SOIL SURVEY OF

Jefferson County, Kansas

United States Department of Agriculture
Soil Conservation Service
in cooperation with
Kansas Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1967–73. Soil names and descriptions were approved in 1974. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1973. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Jefferson County Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, ranching, industry, and recreation.

Locating Soils

All the soils of Jefferson County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. This soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The Guide to Mapping Units can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the woodland group, the pasture group, and the range site to which the soil has been assigned.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the descriptions of the capability units and the woodland groups.

Foresters and others can refer to the section "Woodland," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife."

Community planners and others can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and recreational facilities in the sections "Engineering" and "Recreation."

Engineers and builders can find, under "Engineering," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in Jefferson County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "Environmental Factors Affecting Soil Use."

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Issued November 1977

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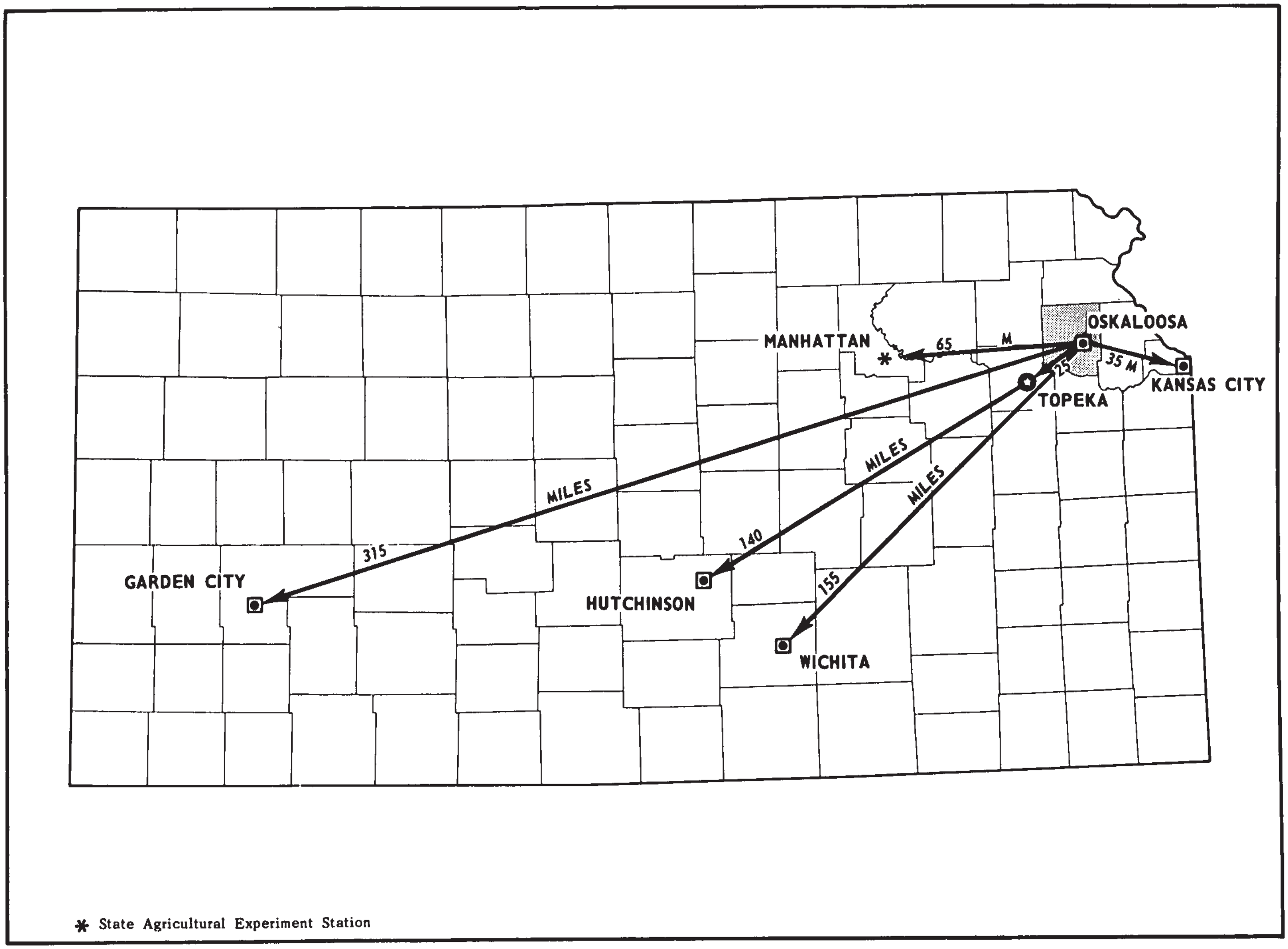

Location of Jefferson County in Kansas.

SOIL SURVEY OF JEFFERSON COUNTY, KANSAS

BY HAROLD P. DICKEY, JEROME L. ZIMMERMAN, AND HAROLD T. ROWLAND,
SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE KANSAS AGRICULTURAL EXPERIMENT STATION[1]

JEFFERSON COUNTY, in the northeastern part of Kansas, covers a total area of 552 square miles, or 353,280 acres. See facing page. In 1973, the population was 12,825. Oskaloosa, the county seat, is in the east-central part of the county.

Farming is the principal industry. Livestock and cash grain enterprises are equally important to the economy of the county. Corn, grain sorghum, soybeans, wheat, and alfalfa are the principal crops.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Jefferson County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes; the size and nature of streams; the kinds of native plants or crops; the kinds of rock and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of classification most used in a local survey.

Soils that have profiles alike or almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Some soil series are named for a town or other geographic feature near the place where they were first observed and mapped. Eudora and Sibleyville, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Grundy silty clay loam, 2 to 5 percent slopes, is one phase within the Grundy series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. One such kind of mapping unit, the soil complex, is shown on the soil map of Jefferson County.

A soil complex consists of areas of two or more soils so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Kimo-Eudora complex is an example.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

[1] WALTER ABMEYER, LARRY D. ZAVESKY, WILLIAM C. BOATRIGHT, and HOWARD V. CAMPBELL, Soil Conservation Service, and ROBERT O. PLINSKY and JAN E. CIPRA, Kansas Agricultural Experiment Station, assisted in the survey.

Soil scientists observe how soils behave when used as a growing medium for native and cultivated plants, and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this failure to the slow permeability of the soil or to a high water table. They see that streets, road pavements, and foundations for houses crack on a given kind of soil, and they relate this failure to a high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict the limitations or suitability of a soil for present and potential use.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Jefferson County. A soil association is a landscape that has a distinctive pattern of soils in defined proportions. It typically consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in an association can occur in other associations, but in different patterns.

A map showing soil associations is useful to people who want to have a general idea of the soils in a survey area, who want to compare different parts of that area, or who want to locate large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide for broad planning on a watershed, a wooded tract, or a wildlife area or for broad planning of recreational facilities, community developments, and such engineering works as transportation corridors. It is not a suitable map for detailed planning for management of a farm or field or for selecting the exact location of a road or building or other structure, because the soils within an association ordinarily vary in slope, depth, stoniness, drainage, and other characteristics that affect their management.

Soil association names and definitions on the general soil map may not fully agree with those of the general soil map in adjacent counties published at a different date. Differences in the maps are the result of improvement in the classification or refinements in soil series concepts.

The five soil associations in Jefferson County are described on the pages that follow.

1. Martin-Vinland-Sogn Association

Deep, moderately well drained, gently sloping to moderately sloping soils and shallow, moderately sloping to steep, somewhat excessively drained soils; on uplands

The landscape of this association is one of narrow to moderately wide convex ridgetops, sloping to moderately steep side slopes, and many drainageways. The soils formed in residuum from interbedded limestone and medium textured and moderately fine textured shale.

This association is on uplands. It makes up about 34 percent of the county. It is about 31 percent Martin soils (fig. 1), 14 percent Vinland soils, 8 percent Sogn soils, and 33 percent less extensive soils. About 14 percent is the lower two-thirds of the Perry Reservoir.

Martin soils are gently sloping to moderately sloping. They are on side slopes and foot slopes below Sogn and Vinland soils. In some areas, they are also above Sogn soils. These deep soils are moderately well drained. The surface layer is black silty clay loam, and the subsoil is black to dark grayish brown silty clay loam. The underlying material is grayish brown silty clay loam.

Vinland soils are shallow, moderately sloping to steep, and somewhat excessively drained. They formed in material weathered from shale. They are generally below Sogn soils and above Martin soils. The surface layer is very dark grayish brown silty clay loam. The subsoil is dark brown silty clay loam, and the underlying material is pale brown silty clay loam. Medium textured and moderately fine textured shale is at a depth of 10 to 20 inches.

Sogn soils are shallow, somewhat excessively drained, and moderately sloping to moderately steep. They are on side slopes, typically below Oska soils and above Martin or Vinland soils. The surface layer is very dark brown to very dark grayish brown silty clay loam. Limestone is at a depth of about 13 inches.

Less extensive in this association are Oska, Kennebec, Gymer, Pawnee, Sibleyville, and Shelby soils. Pawnee and Shelby soils are on ridgetops above Sogn soils. Oska soils are directly above Sogn soils on side slopes. Gymer and Sibleyville soils are below Sogn soils on side slopes. Kennebec soils, channeled, are in small valleys that enclose meandering streams.

This association is about 54 percent pasture, 30 percent cultivated crops, and 16 percent urban and recreation areas. Although the trend is toward an increase in urban and recreation use, livestock farming and general cash-grain farming are the main enterprises. Most of the limestone quarries are within this association.

The chief concerns of management are maintaining and improving grass production, fertility, and tilth and controlling water erosion. Wheat, soybeans, grain sorghum, and corn are the main crops. Limitations for urban development are a slow percolation rate, a high shrink-swell potential, shallowness over bedrock, and, in some areas, steep slopes.

2. Pawnee-Martin-Vinland Association

Deep, moderately well drained, gently sloping to strongly sloping soils and shallow, somewhat exces-

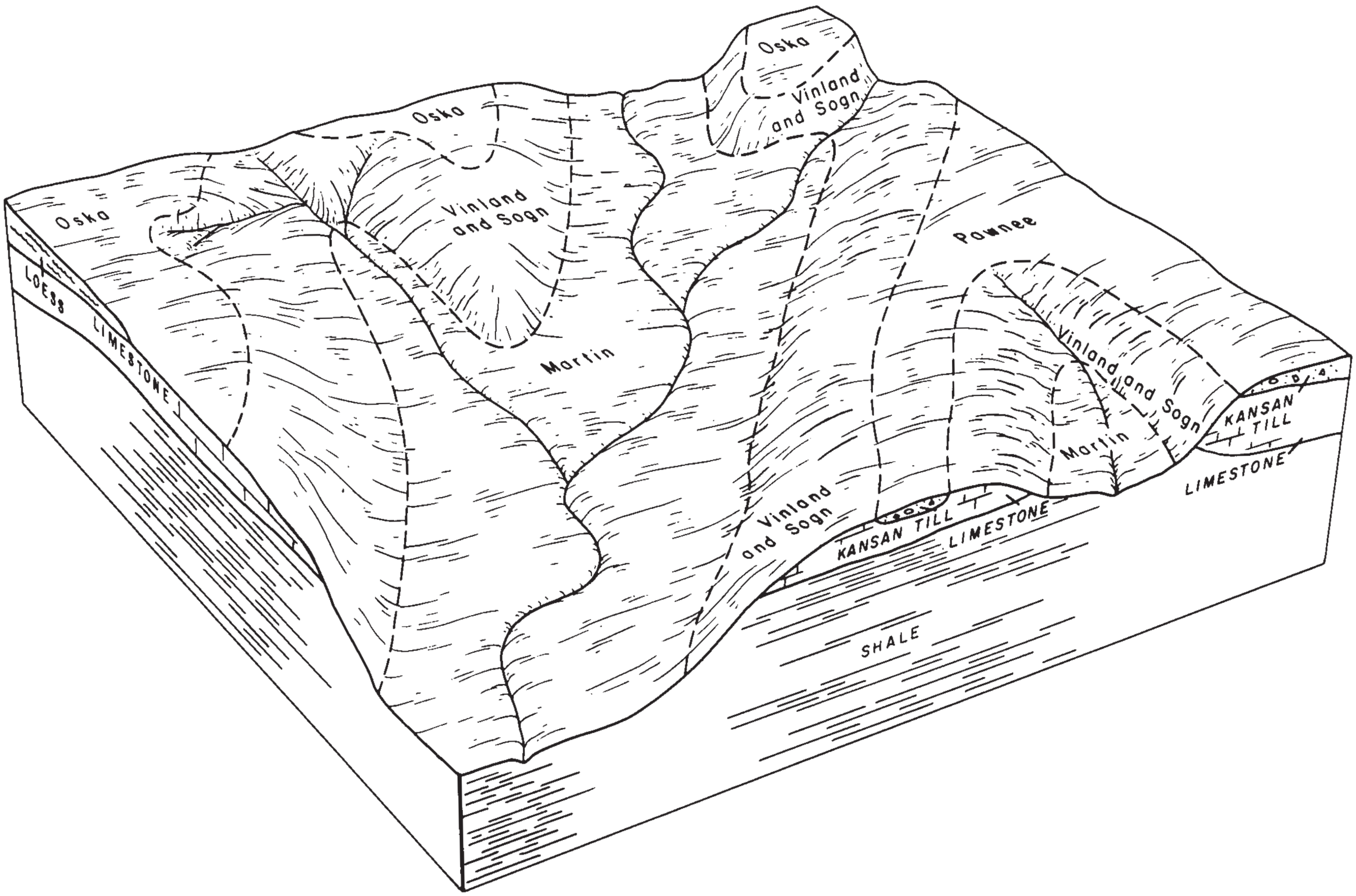

Figure 1.—**Pattern of soils in Martin-Vinland-Sogn association.**

sively drained, moderately sloping to steep soils; on uplands

The landscape of this association is one of moderately wide ridgetops and long side slopes. The soils formed in glacial till and glaciofluvial sediments and in material weathered from shale.

This association, about 16 percent of the county, is about 40 percent Pawnee soils, 21 percent Martin soils, 15 percent Vinland soils, and 24 percent less extensive soils.

Pawnee soils are gently to strongly sloping and moderately well drained. They are on ridgetops and side slopes. The surface layer is very dark grayish brown clay loam. The subsoil is dark brown to light olive brown clay. The underlying material is light olive brown clay.

Martin soils are gently to moderately sloping and are on side slopes and foot slopes below Pawnee and Vinland soils. These deep soils are moderately well drained. The surface layer is black silty clay loam, and the subsoil is black to dark grayish brown silty clay loam. The underlying material is grayish brown silty clay loam.

Vinland soils are shallow, moderately sloping to steep, and somewhat excessively drained. These soils formed in material weathered from shale. They are typically at mid slope, below Pawnee and Sogn soils and above Martin soils. The surface layer is very dark grayish brown silty clay loam. The subsoil is dark brown silty clay loam, and the underlying material is pale brown silty clay loam. Medium textured and moderately fine textured shale is at a depth of 10 to 20 inches.

Less extensive in this association are Oska, Sogn, Kennebec, Sibleyville, Haig, Morrill, Gymer, and Shelby soils. Haig, Morrill, and Shelby soils are on ridgetops above Sogn soils. Oska soils are on side slopes directly above Sogn soils. Gymer and Sibleyville soils are on side slopes below Sogn and Pawnee soils. Kennebec soils, channeled, are in small valleys that enclose meandering streams.

About 60 percent of this association is cultivated. The rest is pastured. A few small areas are used for wildlife and urban development. General cash-grain farming and livestock farming are the chief enterprises.

Controlling water erosion and maintaining and improving fertility, tilth, and grass production are the chief concerns in management. Wheat, soybeans, grain sorghum, and corn are the main crops. The main limitations for urban development are a slow percola-

tion rate, a high shrink-swell potential, and shallowness over bedrock.

3. Pawnee-Grundy-Shelby Association

Deep, nearly level to strongly sloping, well drained to somewhat poorly drained soils on uplands

The landscape of this soil association is one of moderately wide ridgetops and long side slopes, The soils formed in glacial till, glaciofluvial deposits, and wind-deposited sediment.

This association, about 36 percent of the county, is about 43 percent Pawnee soils (fig. 2), 25 percent Grundy soils, 24 percent Shelby soils, and 8 percent less extensive soils.

Pawnee soils are gently sloping to strongly sloping and moderately well drained. They are on side slopes below Grundy soils. In the parts of this association where Grundy soils do not occur, Pawnee soils occupy the ridgetops and side slopes. The surface layer is very dark grayish brown clay loam. The subsoil is dark brown to light olive brown clay. The underlying material is light olive brown clay.

Grundy soils are nearly level to moderately sloping and moderately well drained to somewhat poorly drained. They are on ridgetops and upper side slopes. The surface layer is black silty clay loam. The subsoil is very dark gray to dark grayish brown silty clay. The underlying material is dark grayish brown silty clay loam.

Shelby soils are moderately to strongly sloping and moderately well drained to well drained. They are on side slopes below Grundy or Pawnee soils. The surface layer is very dark grayish brown loam. The subsoil is dark brown to dark yellowish brown clay loam. The underlying material is dark brown sandy clay loam.

Less extensive in this association are Martin, Morrill, Sogn, Vinland, Kennebec, Konawa, Gymer, and Oska soils. Martin, Sogn, and Vinland soils are on lower side slopes. Kennebec soils, channeled, are in small drainageways. Gymer and Konawa soils are on bluffs along the Kansas River Valley. Morrill soils are on ridgetops and upper side slopes.

Most of this association is cultivated. Some areas are used for pasture or urban development. General

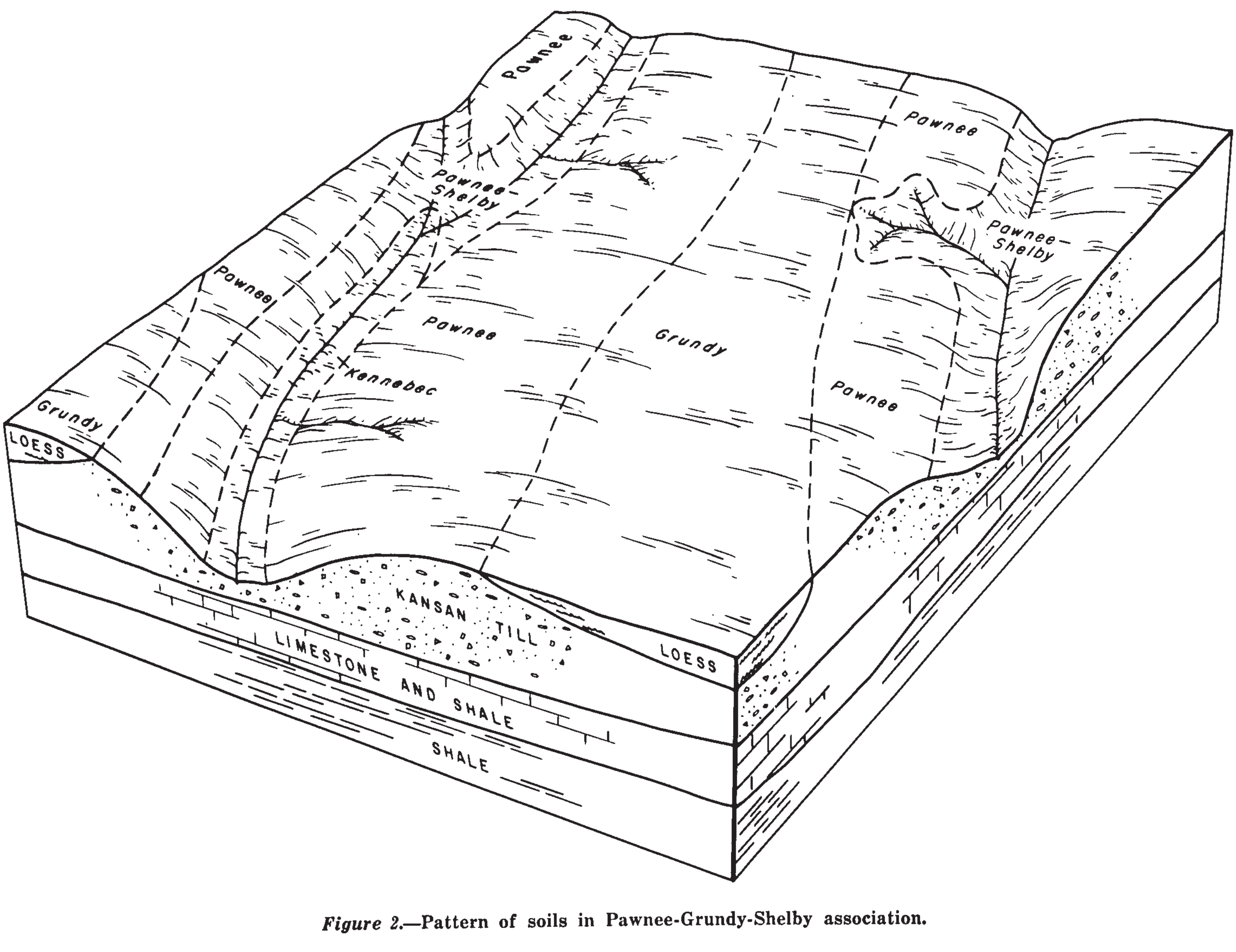

Figure 2.—Pattern of soils in Pawnee-Grundy-Shelby association.

cash-grain farming and livestock farming are chief enterprises.

Controlling water erosion and maintaining and improving fertility, tilth, and grass production are the main concerns of management. Corn, wheat, soybeans, and grain sorghum are the main crops. The main limitations for urban development are a slow percolation rate and a high shrink-swell potential.

4. Kennebec-Wabash-Reading Association

Deep, nearly level, well drained to very poorly drained soils on bottom lands

This association is on flood plains and terraces along larger streams. It makes up about 10 percent of the county. It is about 35 percent Kennebec soils (fig. 3), 18 percent Wabash soils, 15 percent Reading soils, and 18 percent less extensive soils. About 14 percent is the upper one-third of the Perry Reservoir.

Kennebec soils are well drained or moderately well drained and nearly level. They are on first bottoms, adjacent to streams, and are occasionally to frequently flooded. The surface layer is very dark brown and very dark grayish brown silt loam. The next layer is very dark grayish brown silt loam. The underlying material is dark grayish brown silt loam.

Wabash soils are nearly level and poorly drained or very poorly drained. They are in backwater areas on high bottoms and low terraces adjacent to upland soils. The surface layer typically is black silty clay loam. The subsoil is very dark gray and grayish brown silty clay. The underlying material is dark gray and dark grayish brown silty clay loam.

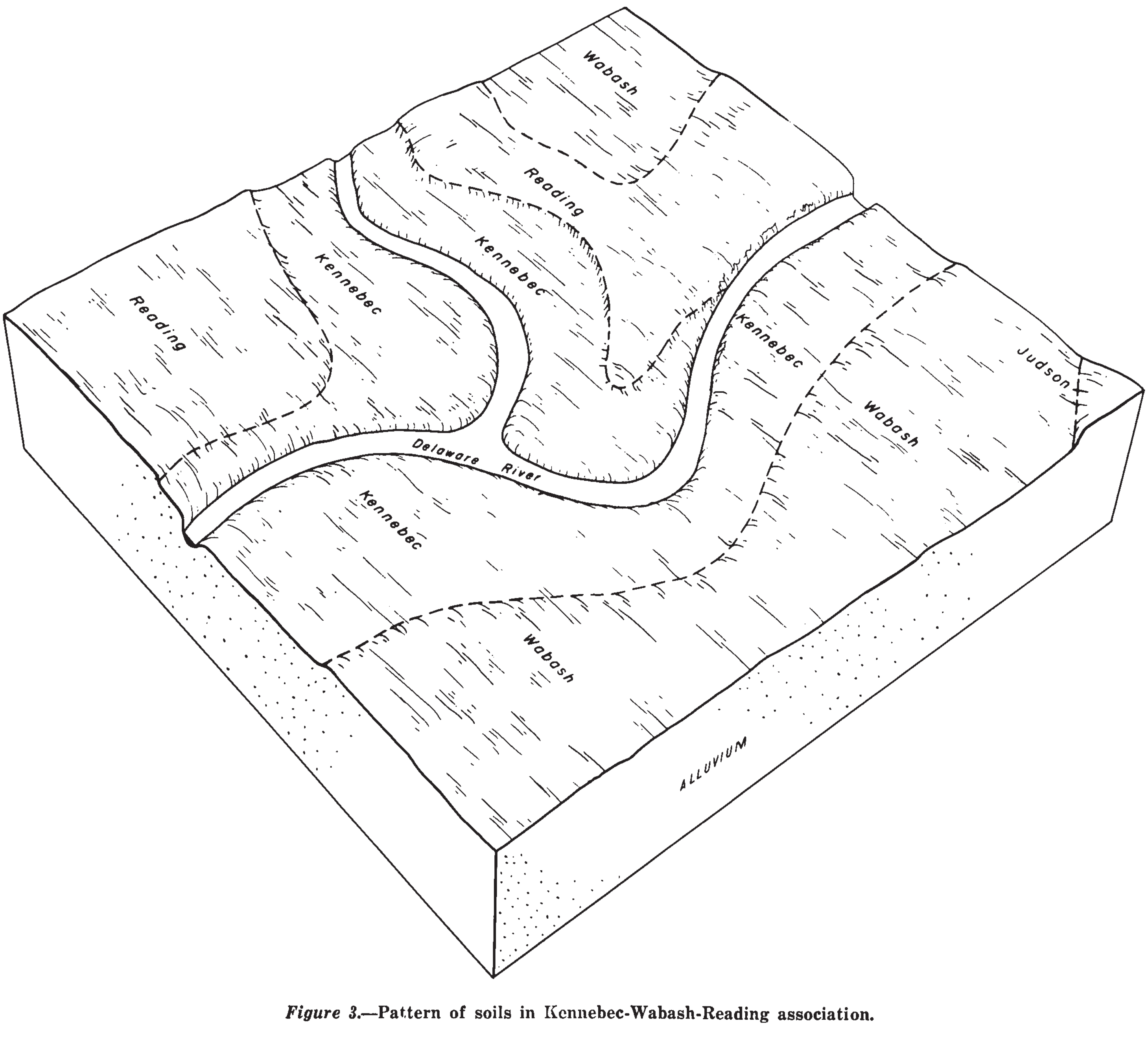

***Figure 3.*—Pattern of soils in Kennebec-Wabash-Reading association.**

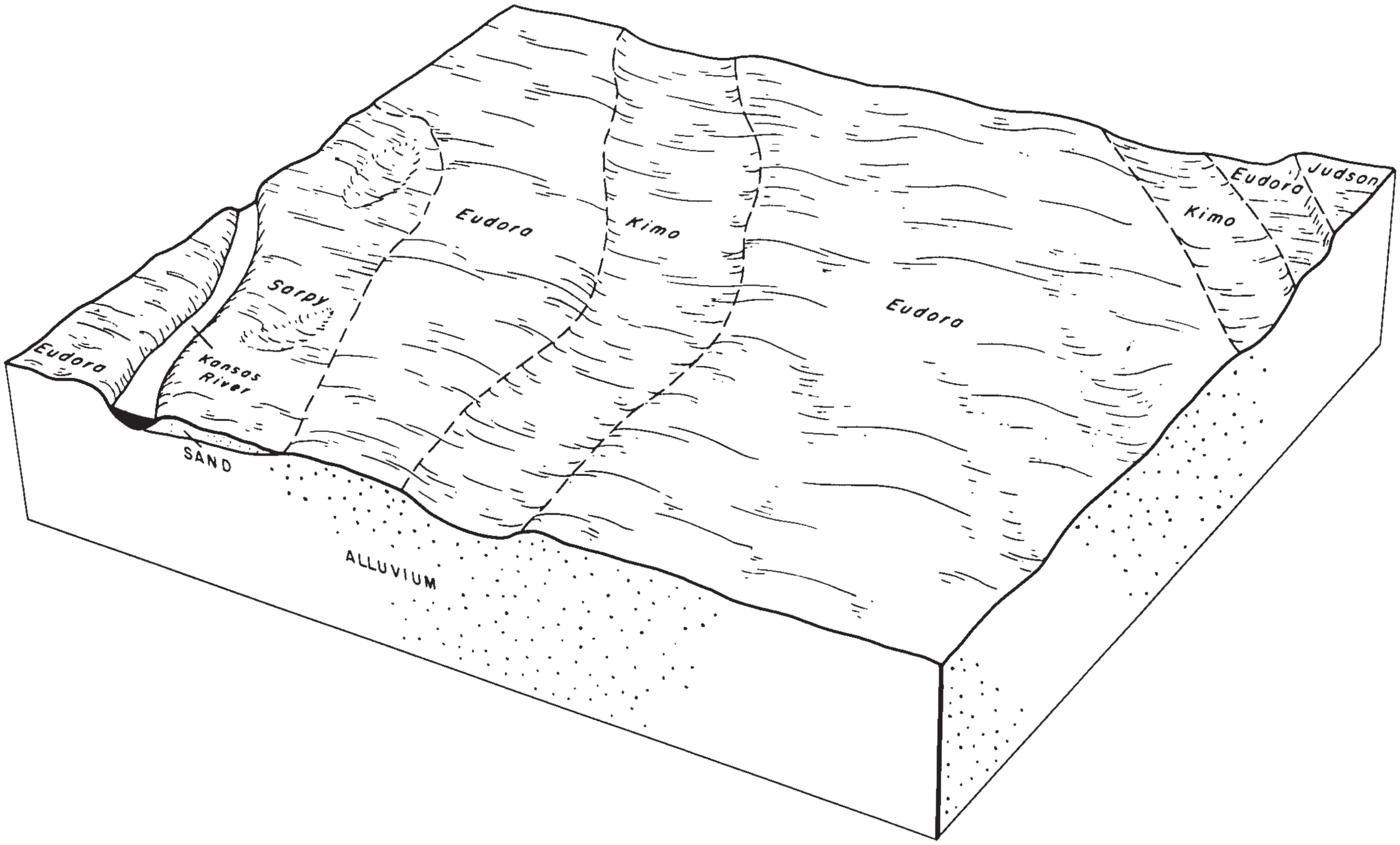

Figure 4.—**Pattern of soils in Eudora-Kimo association.**

Reading soils are nearly level and well drained. They are on high bottoms and terraces. These soils are either in the same landscape position as Wabash soils or between Kennebec and Wabash soils. The surface layer is very dark brown silt loam and silty clay loam. The subsoil is dark brown to very dark grayish brown silty clay loam. The underlying material is dark brown silty clay loam.

Less extensive in this association are Judson soils. They are on the nearly level terrace along the Kansas River.

Most of this association is cultivated. Some areas are used for woodland, wildlife, or recreation. General cash-grain farming is the main enterprise.

The chief concerns of management are poor drainage and occasional flooding and the need to maintain and improve fertility and tilth. Corn, soybeans, wheat and grain sorghum are the main crops. Kennebec, Reading, and Judson soils are suitable for trees. The chief limitation for urban development is the possible flooding.

5. Eudora-Kimo Association

Deep, nearly level to gently undulating, well drained and somewhat poorly drained soils on bottom lands

This soil association is on the flood plain along the Kansas River. It makes up about 4 percent of the county. It is about 47 percent Eudora soils (fig. 4), 27 percent Kimo soils, and 26 percent less extensive soils.

Eudora soils are nearly level to gently undulating and well drained. They are on the higher areas of the flood plain. The surface layer is very dark grayish brown silt loam. The underlying material is grayish brown silt loam.

Kimo soils are nearly level and somewhat poorly drained. They occupy the low areas of the flood plain. The surface layer typically is very dark gray to very dark grayish brown silty clay loam and silty clay. The next layer is grayish brown silty clay loam. The underlying material is grayish brown silt loam.

Less extensive in this association are Sarpy and Judson soils. Sarpy soils are adjacent to the river. Judson soils are on the nearly level terrace along the Kansas River Valley.

Nearly all of this association is cultivated. A narrow area adjacent to the river is wooded. Sand can be mined from the river, and there are a few sand pits. The trend in use of this association is toward farming. General cash-grain farming is the chief enterprise.

The main concerns of management are controlling soil blowing and maintaining fertility and tilth. Water ponds on Kimo soils following periods of excessive rainfall, and the ponding affects row crops. Flooding is rare but damaging. Corn, alfalfa, soybeans, and wheat are the main crops. Vegetable crops, orchards,

and trees are well suited. Limitations for urban development are possible flooding and contamination of ground water by sewage effluent.

This association is suitable for irrigation. Water is available from wells or the river.

Descriptions of the Soils

This section describes the soil series and mapping units in Jefferson County. A soil series is described in detail, and then, briefly, each mapping unit in that series. Unless specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for moist soil unless otherwise stated. If the profile of a given mapping unit differs from the one described for the series, the differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit.

The general management of soil in this county is suggested under the heading "Planning the Use and Management of the Soils."

Preceding each mapping unit is a symbol. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, the range site, the pasture suitability group, and the woodland group to which the mapping unit has been assigned. The page for the description of each mapping unit can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey. More detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*18*)[2].

The names, descriptions, and delineations of soil in this published soil survey do not always agree or join fully with soil maps of adjoining counties published at an earlier date. Such differences result mainly from changes in the concept of soil classification that have occurred since publication. In addition, the correlation of a recognized soil is based on the acreage of that soil and the dissimilarity to adjacent soils within the survey area. Frequently, it is more feasible to map soils of minor extent with similar soils if management and response is much the same. The soil descriptions in this publication reflect these combinations. Still other differences result from the range in slope allowed within the mapping unit for each survey and from the predominance of different soils in mapping units of two or three soils.

[2] Italic numbers in parentheses refer to Literature Cited, p. 63.

TABLE 1.—*Acreage and proportionate extent of the soils*

Map symbol	Soil name	Acres	Percent	Map symbol	Soil name	Acres	Percent
Ec	Eudora complex, overwash	3,250	1.0	Pc	Pawnee clay loam, 3 to 7 percent slopes	53,980	15.2
Gb	Grundy silty clay loam, 0 to 2 percent slopes	10,640	3.0	Ph	Pawnee soils, 3 to 7 percent slopes, eroded	6,450	2.0
Gc	Grundy silty clay loam, 2 to 5 percent slopes	22,980	6.5	Re	Reading silt loam	5,420	1.5
Gy	Gymer silt loam, 3 to 7 percent slopes	4,390	1.2	Sb	Sarpy-Eudora complex, overwash	1,950	.6
Hc	Haig silty clay loam	1,810	.5	Sc	Shelby-Pawnee complex, 3 to 8 percent slopes	48,990	14.0
Ju	Judson silt loam	2,760	.8	So	Shelby-Pawnee complex, 8 to 12 percent slopes	6,110	1.7
Kb	Kennebec silt loam	12,770	3.6	Ss	Sibleyville complex, 3 to 7 percent slopes	2,880	.8
Kc	Kennebec soils, channeled	9,280	2.6	Sv	Sibleyville complex, 7 to 12 percent slopes	840	.2
Km	Kimo silty clay loam	1,100	.3	Sw	Sogn-Vinland complex, 5 to 20 percent slopes	13,020	4.1
Ko	Kimo-Eudora complex	3,540	1.0	Vc	Vinland complex, 3 to 7 percent slopes	10,470	3.1
Kv	Konawa complex, 4 to 10 percent slopes	1,160	.3	Vo	Vinland complex, 7 to 15 percent slopes	21,940	6.1
Mb	Martin silty clay loam, 1 to 3 percent slopes	970	.3	Vx	Vinland-Rock outcrop complex, 20 to 40 percent slopes	18,270	5.2
Mc	Martin silty clay loam, 3 to 8 percent slopes	25,700	7.3	Wc	Wabash silty clay loam	5,030	1.4
Mh	Martin soils, 3 to 8 percent slopes, eroded	4,490	1.3	Wh	Wabash silty clay	1,550	.4
Mo	Martin-Oska silty clay loams, 3 to 6 percent slopes	15,570	4.4		Quarries, borrow areas, etc	990	.3
Mv	Morrill loam, 3 to 7 percent slopes	2,970	.8		Water	26,880	7.0
Oc	Oska silty clay loam, 2 to 6 percent slopes	3,840	1.1				
Pb	Pawnee clay loam, 1 to 3 percent slopes	1,290	.4		Total	353,280	100.0

Small areas of highly contrasting soils or special features, such as rock outcrop, that affect the use of soils are identified by spot symbols on the soil map.

The spot symbol for rock outcrop, for example, is used in areas of moderately deep and deep soils that do not normally have outcrops of bedrock. Each symbol represents an area 1 to 3 acres in size. Rock outcrop interferes with tillage and with harvesting. It is also significant in the construction of terraces and waterways.

Each symbol for a severely eroded spot represents an area about 2 acres in size. Crop growth is generally poor in these areas because fertility is low and tilth is poor. Preparing a seedbed is difficult if clayey material has been exposed by erosion.

Unless otherwise stated, the native plant cover on all the soils is tall and mid grasses.

Eudora Series

The Eudora series consists of deep, nearly level to gently undulating soils on flood plains. These soils formed in loamy and silty alluvium. The native vegetation is tall prairie grasses and deciduous trees.

In a representative profile, the surface layer is very dark grayish brown silt loam about 12 inches thick. The underlying material is grayish brown coarse silt loam.

Eudora soils are well drained. They have high natural fertility and available water capacity. Permeability is moderate.

Representative profile of Eudora silt loam in an area of Kimo-Eudora complex, 2,350 feet south, 200 feet east of northwest corner of sec. 32, T. 11 S., R. 19 E. in a cultivated field:

A1—0 to 12 inches; very dark grayish brown (10YR 3/2) silt loam; weak fine and medium granular structure; very friable; neutral; clear smooth boundary.

C1—12 to 36 inches; grayish brown (10YR 5/2) coarse silt loam; massive; very friable; neutral; gradual smooth boundary.

C2—36 to 42 inches; grayish brown (10YR 5/2) coarse silt loam; massive; very friable; mildly alkaline; gradual smooth boundary.

C3—42 to 65 inches; grayish brown (10YR 5/2) coarse silt loam and numerous thin strata of very fine sandy loam; massive; very friable; moderately alkaline; strong effervescence.

The A horizon ranges from 10 to 20 inches in thickness. Where sediments were deposited by the flood in 1951, the A horizon is dark grayish brown. The A horizon is silt loam, fine sandy loam, or very fine sandy loam. Reaction is slightly acid to neutral. The C horizon above 36 inches is typically silt loam and thin layers that are more sandy or clayey. Below 36 inches, the texture is silt loam, loam, very fine sandy loam, fine sandy loam, or loamy very fine sand that is typically calcareous.

Eudora soils are near Kimo, Sarpy, Kennebec, and Judson soils. They contain less clay in the upper 40 inches than Kimo soils, and less sand throughout than Sarpy soils. They are less clayey throughout and are dark to a lesser depth than Kennebec and Judson soils.

Ec—Eudora complex, overwash. This nearly level mapping unit is on the lower parts of the flood plain along the Kansas River. Slopes are 0 to 2 percent. Areas are 20 to several hundred acres in size.

About 65 percent of this mapping unit is the Eudora soil. The rest is a Kimo soil, a soil intermediate in texture between the Eudora and Kimo soils, and a Sarpy soil. Eudora and Sarpy soils are on higher parts of the landscape, and Kimo and the intermediate soil are on the lower parts, which are typically concave or depressional.

The surface layer is generally very dark grayish brown to dark grayish brown and ranges from silt loam to fine sandy loam. From 6 to 24 inches of these sandy and silty sediments were deposited by the flood of 1951. Following the flood, several areas were plowed to depths of 20 to 48 inches.

Soil blowing is a slight hazard on the Eudora soil, and ponding is a slight problem in the low lying areas. Flooding is rare. The main concerns of management are controlling soil blowing and removing or controlling excess water.

Most of the acreage is cultivated. All crops commonly grown in this county are well suited. Capability unit IIw–1; Loamy Lowland range site; pasture suitability group A–1; woodland suitability group 2o.

Grundy Series

The Grundy series consists of deep, nearly level to moderately sloping soils on uplands. These soils formed in moderately fine textured loess.

In a representative profile the surface layer is black silty clay loam about 15 inches thick (fig. 5). The subsoil is about 40 inches thick. It is very dark gray, very dark grayish brown, and dark grayish brown, firm to very firm silty clay. The underlying material is dark grayish brown silty clay loam.

Grundy soils are moderately well drained to somewhat poorly drained. They have high available water capacity and natural fertility. Permeability is slow.

Most of the acreage is cultivated. All crops commonly grown in the county are well suited.

Representative profile of Grundy silty clay loam, 0 to 2 percent slopes, 850 feet east, 50 feet north of southwest corner of sec. 32, T. 7 S., R. 19 E. in a cultivated field:

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam; moderate fine granular structure; friable; neutral; clear smooth boundary.

A12—8 to 15 inches; black (10YR 2/1) silty clay loam; moderate medium granular structure; friable; medium acid, gradual smooth boundary.

B21t—15 to 19 inches; very dark gray (10YR 3/1) light silty clay; moderate very fine and fine subangular blocky structure; firm; few fine black concretions; medium acid; gradual smooth boundary.

B22t—19 to 34 inches; very dark grayish brown (10YR 3/2) silty clay; streaks of black (10YR 2/1); few faint strong brown (7.5YR 5/6) mottles; moderate fine and medium subangular blocky structure; very firm; few fine black concretions; slightly acid; gradual smooth boundary.

B3—34 to 55 inches; dark grayish brown (10YR 4/2) light silty clay; common faint strong brown (7.5YR 5/6) mottles; moderate medium and coarse subangular structure; a few films on peds; very firm; few fine black concretions and numerous stains; neutral; gradual smooth boundary.

C—55 to 88 inches, dark grayish brown (10YR 4/2) silty clay loam mottled with gray (10YR 5/1) and strong brown (7.5YR 5/6); massive; firm; neutral; few fine black concretions and stains; numerous visible pores.

Texture of the A horizon ranges from heavy silt loam to light silty clay loam. Color of the A horizon ranges from

Figure 5.—**Profile of Grundy silty clay loam, 0 to 2 percent slopes.**

black to very dark grayish brown. Depth to the B horizon ranges from 8 to 18 inches.

Grundy soils are near Pawnee and Shelby soils. They contain more clay and less sand throughout the solum than Shelby soils. They contain less sand throughout the solum than Pawnee soils.

Gb—Grundy silty clay loam, 0 to 2 percent slopes. This nearly level soil is on ridgetops. It has the profile described as representative for the Grundy series. Individual areas range from 4 to 360 acres in size. Included with this soil in mapping are small areas of Pawnee, Shelby, and Oska soils.

Runoff is slow, and the erosion hazard is slight. The main concern of management is control of runoff. As a result of slow runoff and slow permeability, this soil is wet for a few days after excessive rain.

Most of the acreage is cultivated. All crops commonly grown in the county are well suited. Capability unit IIe–1; Loamy Upland range site; pasture suitability group A–2; not assigned to a woodland suitability group.

Gc—Grundy silty clay loam, 2 to 5 percent slopes. This gently sloping to moderately sloping soil is on the tops and upper sides of ridges in rolling landscapes. It has a profile similar to the one described as representative of the Grundy series, but the surface layer is thinner. Individual areas range from 10 to 500 in size. Included with this soil in mapping are small areas of Pawnee, Shelby, and Oska soils. Small eroded areas are identified by spot symbols on the soil map.

Runoff is slow to medium, and the erosion hazard is moderate. The main concern of management is control of erosion.

Most of the acreage is cultivated. A few acres are pastured. All crops commonly grown in the county are well suited. Capability unit IIIe–2; Loamy Upland range site; pasture suitability group A–2; not assigned to a woodland suitability group.

Gymer Series

The Gymer series consists of deep, moderately sloping soils on uplands. These soils formed in silty sediments. The native vegetation is typically tall prairie grasses. In some areas, it is oak-hickory forest and an understory of tall prairie grasses.

In a representative profile the surface layer is very dark grayish brown silt loam about 11 inches thick. The subsoil extends to a depth of 60 inches. The upper 6 inches is dark brown, friable silty clay loam. The next 20 inches is dark reddish brown and reddish brown, firm silty clay loam. The lower 23 inches is coarsely mottled yellowish red and brown, firm silty clay loam.

Gymer soils are well drained. They have high available water capacity and natural fertility. Permeability is moderately slow.

Most of the acreage is cultivated. All crops commonly grown in the county are well suited.

Representative profile of Gymer silt loam, 3 to 7 percent slopes, 2,600 feet west and 1,100 feet south of northeast corner of sec. 13, T. 11 S., R. 16 E. in tall native grasses:

A1—0 to 11 inches; very dark grayish brown (10YR 3/2) silt loam; moderate medium and fine granular structure; friable; medium acid; gradual smooth boundary.

B1—11 to 17 inches; dark brown (7.5YR 3/2) silty clay loam; moderate fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B21t—17 to 24 inches; dark reddish brown (5YR 3/3) silty clay loam; moderate fine and medium subangular blocky structure; firm; medium acid; gradual smooth boundary.

B22t—24 to 37 inches; reddish brown (5YR 4/4) silty clay loam; moderate medium subangular structure; firm; medium acid; gradual smooth boundary.

B3—37 to 60 inches; coarsely mottled yellowish red (5YR 4/6) and brown (7.5YR 5/3) silty clay loam; thin

discontinuous dark films; very few, fine iron and manganese concretions; weak medium subangular blocky structure; firm; medium acid.

The A1 horizon is silt loam in most places, but it ranges to light silty clay loam. Reaction is slightly acid to strongly acid. Color in the B and C horizons ranges from brown to reddish brown, and texture ranges from silty clay loam or clay loam to light silty clay. Reaction is slightly acid to medium acid.

Gymer soils are near Martin, Oska, and Konawa soils. They are browner and less clayey than Martin soils. They are deeper over limestone than Oska soils, which are underlain by limestone at 40 inches or less. Gymer soils are not so sandy as Konawa soils.

Gy—Gymer silt loam, 3 to 7 percent slopes. This moderately sloping soil is on lower side slopes and foot slopes. Individual areas range from 5 to 180 acres in size. Included in mapping are small areas of Martin, Morrill, and Konawa soils and a few small eroded areas, which are identified by spot symbols on the soil map. Also included are soils that are similar to this Gymer soil but have a light colored surface and subsurface layer.

Runoff is medium to rapid, and the erosion hazard is moderate to high. The main concern of management is control of erosion.

About 60 percent of the acreage is cultivated. The rest is used for tame and native grass pasture. Scattered trees are in some native grass areas. All crops commonly grown in the county are well suited. Capability unit IIIe–1; Loamy Upland range site; pasture suitability group A–2; not assigned to a woodland suitability group.

Haig Series

The Haig series consists of deep, nearly level soils on the uplands. These soils formed in moderately fine and fine textured sediments.

In a representative profile the surface layer is black silty clay loam about 9 inches thick. The subsoil is about 41 inches thick. It is very dark gray and dark grayish brown, very firm silty clay in the upper part and grayish brown, firm silty clay loam in the lower part. The underlying material is dark gray silty clay loam.

Haig soils are somewhat poorly drained. They have high available water capacity and fertility. Permeability is very slow.

Representative profile of Haig silty clay loam, 100 feet east and 50 feet north of the southwest corner of sec. 10, T. 9 S., R. 17 E. in native meadow:

A1—0 to 9 inches; black (10YR 2/1) light silty clay loam; weak to moderate fine granular structure; friable; gray coatings on peds in lower inch; medium acid; abrupt smooth boundary.

B21t—9 to 26 inches; very dark gray (10YR 3/1) silty clay; weak to moderate medium subangular blocky structure; very firm; distinct and continuous clay films; neutral; gradual smooth boundary.

B22t—26 to 31 inches; dark grayish brown (2.5Y 4/2) silty clay; weak to moderate medium subangular blocky structure; very firm; thin, continuous clay films; mildly alkaline; clear smooth boundary.

B3—31 to 50 inches; grayish brown (2.5Y 5/2) heavy silty clay loam; common, fine, distinct mottles of strong brown (7.5YR 5/6); weak prismatic structure; firm; few, fine $CaCO_3$ concretions at 31 to 35 inches; porous; mildly alkaline; clear smooth boundary.

C2—50 to 77 inches; dark gray (10YR 4/1) heavy silty clay loam; few, fine, faint, yellowish brown (10YR 5/4) mottles; massive; firm; porous, mildly alkaline; clear smooth boundary.

The A horizon is heavy silt loam or light silty clay loam 6 to 14 inches thick.

The Haig soils in this county have a thinner surface layer and therefore are shallower over silty clay than is typical. The entire profile is more alkaline than is defined as the range for the series. These differences, however, do not alter use and management.

Haig soils are near Martin and Pawnee soils. In contrast with Martin soils, they have an abrupt boundary between the A and B horizons. They have less sand in all horizons than Pawnee soils.

Hc—Haig silty clay loam. This nearly level soil is on ridges and old high terraces. Slopes are 0 to 2 percent. Individual areas are irregular in shape and range from 12 to several hundred acres in size.

Included with this soil in mapping are small areas of Martin, Grundy, and Pawnee soils. Also included, and identified by spot symbols on the soil map, are small eroded areas near the upper end and along the sides of small drains and areas of as much as 3 acres where the surface is scabby or clayey. These scabby or clayey areas are difficult to cultivate and are usually ponded temporarily during periods of excess rainfall.

Runoff is slow, and the erosion hazard is slight. The main concern of management is control of runoff. Slow runoff and very slow permeability make this soil wet for a few days after excessive rain. The soil is somewhat droughty, however, if it does not receive a moderate amount of rain every week during the growing season.

Most of the acreage is cultivated. The soil is suited to all crops commonly grown in the county. It usually produces higher yields of wheat, grain sorghum and soybeans than of corn. Capability unit IIs–1; Clay Upland range site; pasture suitability group C; not assigned to a woodland suitability group.

Judson Series

The Judson series consists of nearly level, deep silty soils that formed in alluvium. These soils are on terraces along the major rivers. The native vegetation is tall prairie grasses and deciduous trees.

In a representative profile the surface layer is very dark gray silt loam about 14 inches thick. The subsoil extends to a depth of 50 inches. It is very dark gray, very dark grayish brown, and dark grayish brown friable silt loam and silty clay loam. The underlying material is grayish brown silt loam.

Judson soils are well drained to moderately well drained. They have a high available water capacity and natural fertility. Permeability is moderate.

Representative profile of Judson silt loam, 2,000 feet south and 2,000 feet east of northwest corner of sec. 19, T. 11 S., R. 18 E. in cultivated field:

Ap—0 to 10 inches; very dark gray (10YR 3/1) silt loam; weak fine granular structure; friable; neutral; gradual smooth boundary.

A12—10 to 14 inches; very dark gray (10YR 3/1) heavy silt loam; moderate medium granular structure and weak fine subangular blocky; friable; numerous worm casts; slightly acid; gradual smooth boundary.

B21—14 to 26 inches; very dark gray (10YR 3/1) heavy silt loam; moderate fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.
B22—26 to 35 inches; very dark grayish brown (10YR 3/2) light silty clay loam; moderate fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.
B3—35 to 50 inches; dark grayish brown (10YR 4/2) light silty clay loam; weak fine subangular blocky structure; friable; numerous worm casts; slightly acid; gradual smooth boundary.
C—50 to 72 inches; grayish brown (10YR 5/2) coarse silt loam; massive; very friable; neutral.

The A horizon is 7 to 16 inches thick. The B horizon ranges from heavy silt loam to light silty clay loam. Reaction is slightly acid to neutral.

Judson soils occur near Eudora and Reading soils. They have a weaker structure and a lower clay content in the B horizon than Reading soils. They are more clayey and are dark colored to a greater depth than Eudora soils.

Ju—Judson silt loam. This nearly level soil is on terraces along the Kansas River. Slopes are 0 to 1 percent. Individual areas range from 15 to several hundred acres. Included with this soil in mapping are small areas of Reading, Eudora, and Wabash soils.

This soil is well suited to all crops commonly grown in the county, including vegetable crops. Nearly all the acreage is cultivated. A few areas are used for urban development. Capability unit I–1; Loamy Lowland range site; pasture suitability group A–1; woodland suitability group 2o.

Kennebec Series

The Kennebec series consists of deep, nearly level soils on flood plains. These soils formed in silty alluvium. Native vegetation is tall prairie grasses and deciduous trees.

In a representative profile the surface layer is very dark brown and very dark grayish brown silt loam about 42 inches thick. The next layer is very dark grayish brown, friable silt loam about 18 inches thick. The underlying material is dark grayish brown silt loam.

Kennebec soils are well drained or moderately well drained. Permeability is moderate. Available water capacity and natural fertility are high.

Representative profile of Kennebec silt loam, 500 feet east, 100 feet south of center of sec. 25, R. 7 S., R. 19 E. in cultivated field:

A11—0 to 24 inches; very dark brown (10YR 2/2) silt loam; weak fine granular structure and weak very fine subangular blocky; friable; slightly acid; gradual smooth boundary.
A12—24 to 42 inches; very dark grayish brown (10YR 3/2) heavy silt loam; moderate to weak medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.
AC—42 to 60 inches; very dark grayish brown (10YR 3/2) heavy silt loam; some stratification; weak medium and fine subangular blocky structure; friable; slightly acid; diffuse boundary.
C—60 to 90 inches; dark grayish brown (10YR 4/2) heavy silt loam; massive; friable; neutral.

The A horizon ranges from silt loam to light silty clay loam. In some places it is mottled with yellowish brown below 30 inches.

Kennebec soils are near Reading and Wabash soils and are in the same geographical areas as Eudora and Sarpy soils. They show less profile development than Reading soils. They have more clay throughout and are dark colored to a greater depth than Eudora soils. They are less clayey than Wabash soils and are less sandy throughout than Sarpy soils.

Kb—Kennebec silt loam. This soil is on first bottoms along the large creeks and the Delaware River (fig. 6). Slopes are 0 to 2 percent. The profile of this soil is the one described as representative of the series. Included in mapping are small areas of Reading and Wabash soils. Also included are a few small areas, along streams that cross the Kansas River Valley, of a similar very dark brown soil that is underlain by black silty clay below 24 inches.

The main concern of management is flooding, which often interferes with seedbed preparation and planting. The flooding is of short duration and usually occurs in spring.

Most of the acreage is cultivated. A few areas are used for tame and native pasture and woodland. All crops commonly grown in this county are well suited. Also, trees grow well on this soil. Capability unit IIw–2; Loamy Lowland range site; pasture suitability group A–1; woodland suitability group 2o.

Kc—Kennebec soils, channeled. This mapping unit is on flood plains. It is cut by meandering stream channels and is subject to frequent flooding. Slopes are 0 to 2 percent. Areas are 150 feet to 400 feet wide.

In most areas these soils have a profile similar to the one described for the Kennebec series, but they range from loam to heavy silty clay loam and are more stratified. Included in mapping are small areas of Wabash, Vinland, Sogn, and Martin soils.

Most of the acreage is used for pasture. Some is used for woodland and wildlife. About 15 percent is suitable for cultivation, but is mostly inaccessible. Only a few acres are cultivated. This unit is well suited to grasses and trees. Capability unit VIw–1; Loamy Lowland range site; pasture suitability group A–1; woodland suitability group 2o.

Figure 6.—Typical landscape of Kennebec silt loam.

Kimo Series

The Kimo series consists of deep, nearly level soils on flood plains. Typically these soils are in lower lying areas along old stream meanders. Kimo soils formed in alluvium consisting of clayey sediments over distinctly contrasting lighter colored loamy sediments. Native vegetation was water-tolerant tall prairie grasses and trees.

In a representative profile the surface layer is about 24 inches thick. It is very dark gray silty clay loam in the upper 7 inches and very dark gray and very dark grayish brown silty clay in the lower 17 inches. The next layer is grayish brown, friable silty clay loam about 6 inches thick. The underlying material is grayish brown silt loam.

Kimo soils are somewhat poorly drained. Permeability is slow. Available water capacity and natural fertility are high.

Representative profile of Kimo silty clay loam, 150 feet south and 100 feet east of northwest corner sec. 6, T. 12 S., R. 19 E. in cultivated field:

Ap—0 to 7 inches; very dark gray (10YR 3/1) heavy silty clay loam; weak fine granular structure; firm; mildly alkaline; gradual smooth boundary.

A11—7 to 17 inches; very dark gray (10 YR 3/1) silty clay; weak, fine and medium subangular blocky structure; very firm; neutral; gradual smooth boundary.

A12—17 to 24 inches; very dark grayish brown (10YR 3/2) light silty clay; weak fine and medium subangular blocky structure; very firm; moderately alkaline; slight effervescence; clear smooth boundary.

AC—24 to 30 inches; grayish brown (10YR 5/2) and streaks and tongues of very dark grayish brown (10YR 3/2) light silty clay loam; weak fine subangular blocky structure to massive; friable; moderately alkaline; gradual smooth boundary.

IIC1—30 to 50 inches; grayish brown (10YR 5/2) coarse silt loam with thin strata of fine sandy loam; massive; very friable; moderately alkaline; strong effervescence; clear smooth boundary.

IIC2—50 to 60 inches; dark grayish brown (10YR 4/2) silt loam; massive; very friable; moderately alkaline; strong effervescence.

Reaction in the A horizon ranges from neutral to moderately alkaline. The upper part of the A horizon ranges from medium silty clay loam to silty clay. Depth to the IIC horizon ranges from 20 to 38 inches. Typically the IIC horizon is coarse silt loam, but in some places it is very fine sandy loam, fine sandy loam, or loamy very fine sand.

Kimo soils are near Wabash, Eudora, and Sarpy soils. They have a loamy C horizon at a depth of less than 40 inches, whereas, Wabash soils are clayey to a depth of more than 40 inches. Kimo soils have a finer textured solum than Eudora and Sarpy soils.

Km—Kimo silty clay loam. This nearly level soil occurs on old stream meanders along the Kansas River. Slopes are 0 to 1 percent and slightly concave. Individual areas are 10 to 130 acres in size. Included with this soil in mapping are small areas of Wabash and Eudora soils and wet areas. Also included are small areas of similar very dark gray soils that are heavy silt loam or light silt loam in the upper 24 inches.

This soil is subject to ponding and has a high water table during periods of excess rainfall. Flooding is rare. Removal of excess water is the main management problem.

Most of the acreage is cultivated. All crops commonly grown in this county are well suited. Capability unit IIw-3; Clay Lowland range site; pasture suitability group E; woodland suitability group 3o.

Ko—Kimo-Eudora complex. This nearly level to gently undulating mapping unit is on the higher parts of the flood plain along the Kansas River. Slopes are 0 to 3 percent. Individual areas are 95 to several hundred acres in size.

About 50 percent of this unit is Kimo silty clay loam, and about 40 percent is Eudora silt loam. The nearly level to gently undulating Eudora silt loam is on the higher parts of the landscape and the nearly level Kimo silty clay loam is on the lower parts, which are typically concave or depressional.

Included with these soils in mapping are areas of a soil that is similar to the Kimo soil, but is less clayey. It occurs between Eudora and Kimo soils. In areas where the Kimo soil does not occur, this soil occupies the lower parts of the landscape. Also included are small areas of the steep Eudora soils and areas of Sarpy, Wabash, and Judson soils.

Soil blowing is a slight hazard on the Eudora soil, and ponding is a slight problem on the Kimo soil. Flooding is rare. The main concern of management is removal or control of excess water.

Most of the acreage is cultivated. All crops common to this county are well suited. Vegetable crops are also well suited. Capability unit IIw-1. Kimo soil in Clay Lowland range site, pasture suitability group E, woodland suitability group 3o; Eudora soil in Loamy Lowland range site, pasture suitability group A-1, woodland suitability group 2o.

Konawa Series

The Konawa series consists of deep, moderately sloping to strongly sloping soils on uplands. These soils formed in loamy sediments. Native vegetation is an oak-hickory woodland and an understory of tall prairie grasses.

In a representative profile the surface layer is dark gray fine sandy loam about 4 inches thick. The subsurface layer is grayish brown fine sandy loam about 9 inches thick. The subsoil extends to a depth of 44 inches. The upper part is dark reddish brown, firm sandy clay loam, and the lower part is reddish brown and brown, firm clay loam. The underlying material is brown to yellowish brown sandy loam.

Konawa soils are well drained. Natural fertility is moderate. Available water capacity is moderate to high. Permeability is moderate.

Representative profile of Konawa fine sandy loam, in an area of Konawa complex, 4 to 10 percent slopes, 300 feet east, 50 feet north of center of sec. 13, T. 11 S., R. 16 E.

A1—0 to 4 inches; dark gray (10YR 4/1) fine sandy loam; weak fine granular structure, very friable; medium acid; abrupt smooth boundary.

A2—4 to 13 inches; grayish brown (10YR 5/2) fine sandy loam; weak fine granular structure; very friable; medium acid; clear smooth boundary.

B21t—13 to 20 inches; dark reddish brown (5YR 3/4) sandy clay loam; weak fine to medium subangular blocky structure; firm; upper 2 inches indicate mixing of A2 and B horizons; medium acid; gradual smooth boundary.

B22t—20 to 36 inches; reddish brown (5YR 4/4) clay loam; moderate fine subangular blocky structure; firm; medium acid; gradual smooth boundary.
B3—36 to 44 inches; brown (7.5YR 5/4) clay loam; weak coarse and medium subangular blocky structure to massive; firm; slightly acid; clear smooth boundary.
C1—44 to 49 inches; yellowish brown (10YR 5/4) sandy loam; massive; very friable; medium acid; diffuse smooth boundary.
C2—49 to 60 inches; brown (10YR 5/3) sandy loam; massive; very friable; slightly acid.

The A horizon is fine sandy loam or sandy loam. The A1 horizon is typically less than 6 inches thick and ranges from dark gray to very dark grayish brown. The A2 horizon ranges in color from grayish brown to brown. The B2t horizon ranges from clay loam to sandy clay loam. The C horizon ranges from sandy loam to clay loam.

The annual temperature of these soils is a few degrees cooler than is defined as the range for the series, but this difference does not alter use or management.

Konawa soils are near Gymer and Morrill soils. They contain more sand and less silt than Gymer soils. They generally contain more sand than Morrill soils, which lack an A2 horizon.

Kv—Konawa complex, 4 to 10 percent slopes. This moderately sloping to strongly sloping mapping unit is on a high old alluvial terrace along the north side of the Kansas River Valley. The landscape is highly dissected by streams. Slopes are convex. Individual areas are 15 to 330 acres.

About 35 percent of this unit is Konawa fine sandy loam, which occurs at mid slope and on ridgetops. About 30 percent is a soil on the lower slopes or foot slopes that has a very dark grayish brown sandy loam surface layer and a dark grayish brown sandy loam subsoil. About 25 percent is a soil on ridgetops that has a very dark grayish brown loamy fine sand surface layer and loamy sand or sand underlying material. Included in mapping are small areas of Gymer, Morrill, and Sogn soils.

Runoff is slow to medium, and the erosion hazard is high. The main concern of management is control of erosion.

About 80 percent of the acreage is used for pasture. A few areas are in tame grasses. The rest is in native grasses or oak-hickory woodland and an understory of tall prairie grasses. This mapping unit is suited to wheat or other small grains, but is best suited to grasses. Capability unit IVe–1; Savannah range site; pasture suitability group B; woodland suitability group 3o.

Martin Series

The Martin series consists of deep, gently sloping to moderately sloping soils on uplands. These soils formed in material weathered from moderately fine and fine textured shale.

In a representative profile the surface layer is black silty clay loam about 9 inches thick. The subsoil is very firm silty clay loam about 51 inches thick. The upper 8 inches is black, the next 9 inches is very dark brown, and the rest is dark grayish brown. The underlying material is grayish brown silty clay loam.

Martin soils are moderately well drained. Permeability is slow. Available water capacity and natural fertility are high.

Representative profile of the Martin silty clay loam, 3 to 8 percent slopes, 1,400 feet south and 200 feet east of northwest corner of sec. 33, T. 9 S., R. 18 E. in a cultivated field:

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam; weak fine granular structure; friable; many fine roots; medium acid; clear smooth boundary.
B1—9 to 12 inches; black (10YR 2/1) silty clay loam; moderate medium blocky structure; very firm; common worm casts; medium acid; clear smooth boundary.
B21t—12 to 17 inches; black (10YR 2/1) heavy silty clay loam; few fine distinct mottles of strong brown (7.5YR 5/6); moderate fine and medium subangular blocky structure and fine blocky; very firm; few fine black concretions; few worm casts; few fine roots; medium acid; gradual smooth boundary.
B22t—17 to 26 inches; very dark brown (10YR 2/2) heavy silty clay loam; few fine faint mottles of yellowish brown (10YR 5/6) and few fine distinct mottles of olive brown (2.5Y 4/4); moderate fine and medium blocky structure; very firm; few fine black concretions; medium acid; gradual smooth boundary.
B23t—26 to 39 inches, dark grayish brown (2.5Y 4/2) heavy silty clay loam; common fine distinct mottles of strong brown (7.5YR 5/6); moderate to weak fine and medium blocky structure; very firm; thin distinct clay films; few limestone fragments; few fine black concretions; slightly acid; gradual smooth boundary.
B3—39 to 60 inches; dark grayish brown (2.5Y 4/2) heavy silty clay loam; common fine distinct mottles of strong brown (7.5YR 5/6); moderate medium prismatic structure parting to weak fine and medium blocky; very firm; thin distinct clay films; few fine black concretions; neutral; gradual smooth boundary.
C—60 to 71 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine distinct mottles of strong brown (7.5YR 5/6); massive; very firm; few black stains on peds; neutral; gradual smooth boundary.

The A horizon ranges from very dark brown to very dark gray or black. Depth to the B2t horizon ranges from 10 to 20 inches. Texture of the B2t horizon ranges from heavy silty clay loam to silty clay. These soils are noncalcareous throughout, but in some places calcium carbonate concretions are in the lower part of the B horizon and in the C horizon.

Martin soils are near Haig, Gymer, and Vinland soils. They contain more clay in all horizons than Gymer soils. They lack the abrupt boundary between the A and Bt horizons that is typical of Haig soils. In contrast with Vinland soils, they are deeper and have a B2t horizon.

Mb—Martin silty clay loam, 1 to 3 percent slopes. This gently sloping soil is on convex ridgetops above limestone outcrops, or on concave foot slopes below limestone outcrops. Areas are 5 to 110 acres. Included in mapping are small areas of Pawnee and Woodson soils.

Runoff is slow to medium, and the erosion hazard is slight. The main concern of management is control of erosion.

Most of the acreage is cultivated. A few areas are used for pasture. All crops commonly grown in this county are well suited. Capability unit IIe–1; Loamy Upland range site; pasture suitability group A–2; not assigned to a woodland suitability group.

Mc—Martin silty clay loam, 3 to 8 percent slopes. This moderately sloping soil is on side slopes, generally below limestone outcrops, but in a few places it occurs above the outcrops. Areas are 10 to several hundred acres. The profile of this soil is the one described as representative of the series. Included in mapping are small areas of a soil that has a dark brown subsoil and formed in material weathered from medium textured

shale. Also included are small areas of Sogn, Sibleyville, Vinland, Oska, Gymer, and Pawnee soils and small eroded areas that are identified by spot symbols on the soil map.

Runoff is medium to rapid, and the erosion hazard is moderate to high. The main concern of management is control of erosion.

About 50 percent of the acreage is cultivated. The rest is used for pasture. All crops commonly grown in this county are well suited. Capability unit IIIe–2; Loamy Upland range site; pasture suitability group A–2; not assigned to a woodland suitability group.

Mh—Martin soils, 3 to 8 percent slopes, eroded. These moderately sloping soils are on side slopes, generally below limestone outcrops and in many places at the upper end and along small drains. The profile is similar to the one described as representative of the series, but the surface layer is a very dark brown to very dark grayish brown silty clay loam or silty clay about 6 to 8 inches thick. In most places the surface layer is a mixture of the original surface layer and material from the subsoil. Shallow gullies have formed, and gully scars are evident. Included in mapping are small areas of Vinland, Sibleyville, Sogn, and Pawnee soils.

Runoff is rapid, and the erosion hazard is high. Tilth is poor. The main concerns of management are improving tilth and controlling erosion.

About 70 percent of the acreage is used for pasture; the rest is cultivated. These soils are best suited to permanent vegetation. If cultivated, they are better suited to wheat than to corn or soybeans. Capability unit IVe–4; Clay Upland range site; pasture suitability group C; not assigned to a woodland suitability group.

Mo—Martin-Oska silty clay loams, 3 to 6 percent slopes. This moderately sloping mapping unit is on upper side slopes and narrow ridges in the southern part of the county, in areas where limestone crops out. The rock formation consists of several layers of interbedded limestone and shale. Individual areas are 5 to several hundred acres in size.

About 40 percent of this unit is Martin silty clay loam. About 30 percent is Oska silty clay loam. About 25 percent is a soil that is similar to Martin silty clay loam, but is underlain by limestone at a depth of 20 to 40 inches.

Included with this soil in mapping are small areas of Sogn and Vinland soils and small severely eroded areas that are identified by spot symbols on the soil map.

Runoff is medium, and the erosion hazard is moderate to high. These soils are often droughty. The main concern of management is controlling erosion and managing crops for the best use of available water. The small areas of shallow soils make cultivation difficult.

About 45 percent of the acreage is cultivated. Wheat and grain sorghum are better suited crops than corn or soybeans. The rest is used for pasture. This mapping unit is better suited to pasture than to cultivated crops. Brome and tall fescue are suitable tame grasses. Capability unit IVe–3; Loamy Upland range site; pasture suitability group A–2; not assigned to a woodland suitability group.

Morrill Series

The Morrill series consists of deep, moderately sloping soils on uplands. These soils formed in glacial till and glaciofluvial deposits.

In a representative profile the surface layer is very dark grayish brown loam about 9 inches thick. The subsoil is 36 inches thick. It is dark brown and reddish brown, friable and firm clay loam in the upper part and dark brown, firm sandy clay loam in the lower part. The underlying material is dark yellowish brown clay loam.

Morrill soils are well drained. Permeability is moderately slow. Available water capacity and natural fertility are high.

Representative profile of Morrill loam, 3 to 7 percent slopes, 2,200 feet south, 150 feet east of northwest corner of sec. 5, T. 10 S., R. 17 E., in cultivated field:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loam; moderate granular structure; friable; slightly acid; gradual smooth boundary.

B1—9 to 14 inches; dark brown (7.5YR 3/2) clay loam; moderate fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B2t—14 to 29 inches; reddish brown (5YR 4/4) clay loam; moderate fine subangular blocky structure; firm; some coarse sand and small pebbles and few black concretions in lower part; slightly acid; gradual smooth boundary.

B3—29 to 45 inches; dark brown (7.5YR 4/4) sandy clay loam; weak medium subangular blocky structure; firm; some pebbles in upper part and a few black concretions; neutral; gradual smooth boundary.

C—45 to 72 inches, dark yellowish brown (10YR 4/4) clay loam; massive; friable; some alternate thin layers of coarse particles; neutral.

The A1 horizon is very dark gray to dark brown light clay loam to loam. Depth to the B2t horizon ranges from 9 to 16 inches. In some places, the B horizon is sandy clay loam or gravelly clay loam. In places the C horizon is clay loam or sandy clay loam. Small pebbles occur throughout in some places.

Morrill soils are near Oska, Pawnee, Shelby, and Konawa soils. They are browner and have less clay in the B horizon than Pawnee soils. They are deeper and contain more sand in all horizons than Oska soils. Morrill soils have a browner B horizon than Shelby soils. In contrast with Konawa soils, they contain less sand and more clay in all horizons and lack an A2 horizon.

Mv—Morrill loam, 3 to 7 percent slopes. This moderately sloping soil occurs on convex side slopes and on narrow ridgetops. Areas range from 5 to 170 acres.

Included with this soil in mapping are small areas of Pawnee and Oska soils, and small severely eroded areas that are identified by spot symbols on the soil map. Also included are small areas of a similar soil where the percentage of gravel is high in all horizons.

Runoff is medium to rapid, and the erosion hazard is moderate to high. The main concern of management is control of erosion.

About 50 percent of the acreage is cultivated. The rest is used for pasture, mostly tame grasses. This soil is well suited to all crops commonly grown in this county. Capability unit IIIe–1; Loamy Upland range site; pasture suitability group A–2; not assigned to a woodland suitability group.

Oska Series

The Oska series consists of moderately deep, moderately sloping soils on uplands. These soils formed in moderately fine textured material weathered from limestone and shale.

In a representative profile, the surface layer is dark brown silty clay loam about 7 inches thick. The subsoil is about 31 inches thick. In sequence downward it is

dark reddish brown, firm silty clay loam; reddish brown, firm silty clay; and dark yellowish brown firm silty clay. Limestone is at a depth of 38 inches.

Oska soils are well drained. Permeability is slow. Available water capacity is moderate, and natural fertility is high.

Representative profile of Oska silty clay loam, 2 to 6 percent slopes, 600 feet south and 2,540 feet west of the northeast corner of sec. 16, T. 10 S., R. 18 E. in grassland:

A1—0 to 7 inches; dark brown (7.5YR 3/2) silty clay loam; moderate medium granular structure; friable; many roots; slightly acid; gradual smooth boundary.

B1—7 to 11 inches; dark reddish brown (5YR 3/3) silty clay loam; moderate fine subangular blocky structure; firm; many roots; slightly acid; gradual smooth boundary.

B21t—11 to 16 inches; reddish brown (5YR 4/3) silty clay; moderate fine and medium subangular blocky structure; firm; many roots; thin clay films cover most faces of peds; few fine black concretions; medium acid; gradual smooth boundary.

B22t—16 to 34 inches; reddish brown (5YR 4/4) silty clay; moderate fine and medium subangular blocky structure; firm; few roots; distinct clay films cover most faces of peds; few fine black concretions; medium acid; clear smooth boundary.

B3—34 to 38 inches; dark yellowish brown (10YR 4/4) silty clay; weak medium subangular blocky structure; firm; few roots; clay films in crevices; neutral; clear boundary.

R—38 inches; limestone.

The thickness of the solum ranges from 20 to 40 inches, and depth to limestone ranges from 24 to 40 inches. The A horizon is 6 to 10 inches thick. The B horizon ranges from 14 to 34 inches in thickness and from silty clay to heavy silty clay loam in texture. In some uncultivated areas this soil has a B1 horizon. In some places it has a C horizon, which ranges from light silty clay to heavy silty clay loam.

Oska soils are near Morrill, Gymer, Sogn, and Vinland soils. They have less sand in all horizons than Morrill soils. They are shallower over bedrock than Gymer soils. Oska soils are deeper over bedrock than Vinland or Sogn soils, both of which lack a B2t horizon.

Oc—Oska silty clay loam, 2 to 6 percent slopes. This moderately sloping soil occurs on narrow ridgetops and side slopes above limestone outcrops. Areas range from 4 to 150 acres.

Included with this soil in mapping are small areas of Grundy, Gymer, Martin, Sogn, and Vinland soils, and small severely eroded areas that are designated by spot symbols on the soil map.

Runoff is medium, and the erosion hazard is moderate. In some places, this soil is droughty. The main concern of management is control of erosion.

About 45 percent of the acreage is cultivated. The rest is used for pasture. All crops commonly grown in this county are well suited. Capability unit IIIe-1; Loamy Upland range site; pasture suitability group A-2; not assigned to a woodland suitability group.

Pawnee Series

The Pawnee series consists of deep, gently to strongly sloping soils on uplands. These soils formed in moderately fine and fine textured glacial till and glaciofluvial deposits.

In a representative profile the surface layer is very dark grayish brown clay loam about 14 inches thick. The very firm clay subsoil is about 30 inches thick. The upper part is dark brown and the lower part is light olive brown. The underlying material is light olive brown clay.

Pawnee soils are moderately well drained. Available water capacity and natural fertility are high. Permeability is slow.

Representative profile of Pawnee clay loam, 3 to 7 percent slopes (1,450 feet east, 900 feet north of southwest corner of sec. 26, T. 10 S., R. 18 E.) in cultivated field:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) light clay loam; moderate very fine granular structure; friable; slightly acid; gradual smooth boundary.

AB—8 to 14 inches; very dark grayish brown (10YR 3/2) clay loam; moderate fine and very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B2t—14 to 29 inches; dark brown (10YR 4/3) clay; coarsely mottled with yellowish brown (10YR 5/6); moderate medium subangular blocky structure; very firm; several glacial pebbles; medium acid; diffuse smooth boundary.

B3—29 to 44 inches, light olive brown (2.5Y 5/4) clay, coarsely mottled with gray (10YR 5/1) and yellowish brown (10YR 5/6); weak coarse angular and subangular blocky structure; very firm; numerous dark colored films and stains; slightly acid; diffuse smooth boundary.

C—44 to 60 inches, light olive brown (2.5Y 5/4) clay, coarsely mottled with light gray (10YR 2/1) and dark brown (10YR 4/3); massive; very firm; numerous dark colored stains; neutral.

The A horizon ranges from loam to clay loam. The B horizon ranges from very dark grayish brown to yellowish brown and contains varying amounts of glacial pebbles and sand. Mottling occurs throughout the B and C horizons. The C horizon ranges from clay to sandy clay loam.

In the mapping unit Pawnee soils, 3 to 7 percent slopes, eroded, the surface layer is thinner and lighter colored than is defined as the range for the Pawnee series. This difference, however, does not greatly affect the use and management.

Pawnee soils formed in the same material as Shelby and Morrill soils. They occupy similar positions as Grundy and Haig soils. Pawnee soils have more clay in the B horizon than Shelby and Morrill soils. They have more sand in all horizons than Grundy and Haig soils.

Pb—Pawnee clay loam, 1 to 3 percent slopes. This gently sloping soil is on ridgetops. Areas range from 20 to 160 acres. The surface layer is generally slightly thicker than the one described as representative of the series. Included in mapping are small areas of Grundy, Shelby, and Martin soils.

Runoff is slow to medium, and the erosion hazard is slight. The main concern of management is control of erosion.

Most of the acreage is cultivated. A few areas are pastured. All crops commonly grown in the county are well suited. Capability unit IIe-1; Loamy Upland range site; pasture suitability group A-2; not assigned to a woodland suitability group.

Pc—Pawnee clay loam, 3 to 7 percent slopes. This moderately sloping soil is on side slopes and ridgetops of uplands. Areas range from 10 to several hundred acres. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of Morrill, Martin, Shelby, Haig, Grundy, Vinland, and Oska soils, and a similar soil that has a reddish brown subsoil. Also included are severely eroded areas that are identified by spot symbols on the soil map. These

eroded soils generally are on steeper slopes or at the upper ends of small drains.

Runoff is medium to rapid, and the erosion hazard is moderate to high. The main concern of management is to control erosion.

About 60 percent of the acreage is cultivated. The rest is pastured. All crops commonly grown in the county are well suited (fig. 7). Capability unit IIIe-2; Loamy Upland range site; pasture suitability group A-2; not assigned to a woodland suitability group.

Ph—Pawnee soils, 3 to 7 percent slopes, eroded. This moderately sloping mapping unit is on side slopes on uplands. It occurs along and at the upper ends of small drains. The profile is similar to the one described as representative of the series, but most of the original surface layer has been removed by erosion. The present surface layer, a dark brown or dark grayish brown heavy clay loam to clay, is a mixture of the original surface layer and the upper part of the subsoil. Shallow gullies have formed and gully scars are evident in most areas.

Included with this soil in mapping are small areas of Martin, Shelby, Grundy, Morrill soils; uneroded Pawnee soils; and severely eroded areas where the surface layer is yellowish brown clay.

Runoff is rapid, and the erosion hazard is high. Tilth is poor. The main concerns of management are improving tilth and controlling erosion.

About 70 percent of the acreage is pastured, and the rest is cultivated. A few areas are idle. This soil is best suited to grasses. If cultivated, it is better suited to wheat than to corn or soybeans. Capability unit IVe-4; Clay Upland range site; pasture suitability group C; not assigned to a woodland suitability group.

Reading Series

The Reading series consists of deep, nearly level soils on second bottoms and terraces along the larger streams. These soils formed in silty alluvium. Native vegetation is tall prairie grasses and deciduous trees.

In a representative profile the surface layer is very

Figure 7.—Corn on Pawnee clay loam, 3 to 7 percent slopes.

dark brown silt loam and light silty clay loam about 14 inches thick. The subsoil is very dark grayish brown and dark brown, friable and firm silty clay loam about 38 inches thick. The underlying material is dark brown silty clay loam.

Reading soils are well drained. Permeability is moderately slow. Available water capacity and natural fertility are high.

Representative profile of Reading silt loam, 1,800 feet north, 500 feet west of southeast corner of sec. 27, T. 8 S., R. 18 E., in cultivated field:

Ap—0 to 7 inches; very dark brown (10YR 2/2) heavy silt loam; moderate fine granular structure; friable; medium acid; gradual smooth boundary.

A1—7 to 14 inches; very dark brown (10YR 2/2) light silty clay loam; moderate fine granular structure; friable; medium acid; gradual smooth boundary.

B1—14 to 24 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate fine and very fine subangular blocky structure; friable; few fine Fe-Mn concretions; slightly acid; gradual smooth boundary.

B2t—24 to 36 inches; dark brown (10YR 3/3) silty clay loam; moderate fine and very fine subangular blocky structure; firm; few fine Fe-Mn concretions; slightly acid; gradual smooth boundary.

B3—36 to 52 inches; dark brown (10YR 3/3) silty clay loam; moderate fine subangular blocky structure; firm; common fine Fe-Mn concretions and stains; slightly acid; diffuse smooth boundary.

C—52 to 74 inches; dark brown (10YR 3/3) silty clay loam; massive; very firm; neutral; few fine Fe-Mn concretions and stains.

The A horizon ranges from silt loam to light silty clay loam. Depth to the B2t horizon ranges from 12 to 25 inches. The B horizon ranges from brown to very dark grayish brown.

Reading soils are near Judson, Kennebec, and Wabash soils. They have stronger structure and are more clayey in the B horizon than Judson soils. They are more clayey in all horizons below the A horizon than Kennebec soils. They are browner and less clayey in all horizons than Wabash soils.

Re—Reading silt loam. This nearly level soil is on second bottoms and terraces. Slopes are 0 to 2 percent. Areas range from 5 to 420 acres.

Included with this soil in mapping are small areas of Wabash, Judson, Kennebec, and Gymer soils and, in the northeastern part of the county, a few small areas of a similar soil that has a light colored subsurface layer.

This soil is rarely flooded. Flooding is usually of short duration and causes little crop damage.

Most of the acreage is cultivated. A few areas are used for pasture or woodland. All crops commonly grown in the county are well suited. Capability unit I-1; Loamy Lowland range site; pasture suitability group A-1; woodland suitability group 2o.

Sarpy Series

The Sarpy series consists of deep, nearly level soils on flood plains. These soils formed in sandy alluvium. Native vegetation is deciduous trees.

In a representative profile the surface layer is grayish brown loamy fine sand about 9 inches thick. The underlying material is pale brown and brown fine sand and coarse sand to a depth of 48 inches. Below this, it is grayish brown and dark grayish brown silt loam and loam.

Sarpy soils are somewhat excessively drained to excessively drained. Natural fertility is high, and available water capacity is low. Permeability is very rapid. The organic-matter content is usually low.

Representative profile of Sarpy loamy fine sand in an area of Sarpy-Eudora complex, overwash, 2,800 feet south, 1,025 feet east of northwest corner of sec. 6, T. 12 S., R. 12 E. in a cultivated field:

A—0 to 9 inches; grayish brown (10YR 5/2) loamy fine sand; single grain; loose; moderately alkaline; slight effervescence; clear smooth boundary.
C1—9 to 40 inches; pale brown (10YR 6/3) fine sand; single grain; loose; moderately alkaline; slight effervescence; smooth boundary.
C2—40 to 48 inches; brown (10YR 5/3) coarse sand; single grain; loose; moderately alkaline; slight effervescence; clear smooth boundary.
IIC1—48 to 52 inches; dark grayish brown (10YR 4/2) loam; massive; friable; mildly alkaline; clear smooth boundary.
IIC2—52 to 60 inches; grayish brown (10YR 5/2) coarse silt loam; massive; very friable; mildly alkaline.

The A horizon is loamy fine sand, fine sand, or fine sandy loam. The A and C horizons combined are 30 to 60 inches thick. The C horizon is fine sand or loamy fine sand that has some thin strata of silt loam. The IIC horizon, which occurs in most places, is silt loam, loam, or fine sandy loam.

Sarpy soils are near Eudora and Kimo soils and occupy the same landscape position as Kennebec soils. They have more sand in all horizons than Eudora, Kimo, and Kennebec soils. They are lighter colored in the upper 28 inches than Kimo soils. They are lighter colored in all horizons than Kennebec soils.

Sb—Sarpy-Eudora complex, overwash. This nearly level mapping unit occurs on the flood plain along the Kansas River. It typically occupies areas nearest the river. Slopes are 0 to 2 percent. Areas range from 14 to 270 acres.

This unit is about 55 percent Sarpy soil and 45 percent Eudora soil. The surface layer of the Eudora soil is lighter colored than is described in the profile representative of the series.

The surface layer in this unit is loamy fine sand, fine sand, fine sandy loam, or silt loam. Several areas have been plowed to a depth of 20 to 48 inches.

Included in mapping are small areas of Kimo soils and a soil that is similar to the Eudora soils but is heavy silt loam or light silty clay loam in the upper 30 inches.

This unit is subject to flooding. Flooding is rare, but damaging. Soil blowing is a moderate hazard. Obtaining a good stand of crops is difficult.

About 75 percent of the acreage is cultivated. The rest is used for woodland or urban purposes. This unit is well suited to crops commonly grown in the county and to vegetable crops and trees. Capability unit IIIw–2. Sarpy soil in Sandy Lowland range site, pasture suitability group B, woodland suitability group 5s; Eudora soil in Loamy Lowland range site, pasture suitability group A–1, woodland suitability group 2o.

Shelby Series

The Shelby series consists of deep, moderately sloping to strongly sloping soils on uplands. These soils formed in glacial till and glaciofluvial deposits.

In a representative profile the surface layer is very dark grayish brown loam about 12 inches thick. The subsoil is 36 inches thick. It is dark brown, friable clay loam in the upper part and dark yellowish brown, firm clay loam in the lower part. The underlying material is dark brown sandy clay loam.

Shelby soils are well drained to moderately well drained. Permeability is moderately slow. Available water capacity and natural fertility are high.

Representative profile of Shelby loam in an area of Shelby-Pawnee complex, 3 to 8 percent slopes, 1,450 feet east, 200 feet north of southwest corner of sec. 11, T. 8 S., R. 19 E. in cultivated field:

A1—0 to 12 inches; very dark grayish brown (10YR 3/2) loam and a few pebbles; moderate fine and medium granular structure; friable; medium acid; gradual smooth boundary.
B1—12 to 18 inches; dark brown (10YR 3/3) clay loam and a few pebbles; moderate meduim granular structure; friable; medium acid; gradual smooth boundary.
B2t—18 to 32 inches; dark yellowish brown (10YR 4/4) clay loam and a few pebbles; moderate medium subangular blocky structure; firm; few films on some peds; few fine black concretions; medium acid; gradual smooth boundary.
B3—32 to 48 inches; dark yellowish brown (10YR 4/4) clay loam and a few pebbles; weak medium and coarse subangular blocky structure; firm; some films on vertical faces of peds; few, fine black concretions; medium acid; gradual smooth boundary.
C—48 to 60 inches; dark brown (7.5YR 4/3) sandy clay loam and a few pebbles; massive; friable; slightly acid.

The A horizon ranges from very dark grayish brown in color and light clay loam to loam in texture. Depth to the B2t horizon ranges from 9 to 16 inches. In some places, the B horizon is sandy clay loam or gravelly clay loam. The C horizon ranges from loam to clay loam or sandy clay loam. Small pebbles occur throughout all horizons in some places.

Shelby soils occur near Pawnee, Morrill, and Grundy soils. They have less clay in the B horizon than Pawnee soils. They have a dark yellowish brown B2 horizon, whereas Morrill soils have a reddish brown B2 horizon. Shelby soils contain more sand in all horizons and less clay in the B horizon than Grundy soils.

Sc—Shelby-Pawnee complex, 3 to 8 percent slopes. This moderately sloping mapping unit is on narrow ridgetops and side slopes. It is about 60 percent Shelby soil and about 30 percent Pawnee soil. The Shelby soil has the profile described as representative of the series. Areas range from 10 to several hundred acres.

Included with this unit in mapping are small areas of Grundy, Morrill, Martin, Vinland, Oska, and Sogn soils. Also included are areas of eroded Shelby and Pawnee soils, which are identified by spot symbols on the soil map; soils that are similar to the Shelby soil but have calcareous material at a depth of less than 40 inches; and soils that are similar to the Pawnee soil but have a subsurface layer. Seepy spots are common.

Runoff is medium to rapid, and the erosion hazard is moderate to high. The main concern of management is to control erosion.

About 60 percent of the acreage is cultivated. The rest is used for pasture. Most of the pasture is tame grasses. All crops commonly grown in the county are well suited. Capability unit IIIe–1; Loamy Upland range site; pasture suitability group A–2; not assigned to a woodland suitability group.

So—Shelby-Pawnee complex, 8 to 12 percent slopes. This strongly sloping mapping unit occurs on the lower parts of slopes along streams. It is about 65 percent

Shelby soil and 25 percent Pawnee soil. Areas range from 5 to 110 acres.

The Shelby soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. The Pawnee soil has a profile similar to the one described as representative of the Pawnee series, but the surface layer is thinner and is not so clayey.

Included with this unit in mapping are small areas of Martin, Vinland, Oska, Morrill and Sogn soils. Also included are areas of eroded Shelby and Pawnee soils, which are identified by spot symbols on the soil map; soils that are similar to the Shelby soil but have calcareous material within a depth of 40 inches; and soils that are similar to Pawnee soils but have a subsurface layer. Seepy spots are common.

Runoff is rapid, and the erosion hazard is high. The main concern of management is to control erosion.

About 65 percent of the acreage is used for pasture. The rest is cultivated. This unit is best suited to grasses. Some areas in native grasses have a large amount of woody vegetation. If cultivated, this unit is better suited to wheat than to corn or soybeans. Capability unit IVe–5; Loamy Upland range site; pasture suitability group A–2; not assigned to a woodland suitability group.

Sibleyville Series

The Sibleyville series consists of moderately deep, moderately sloping to strongly sloping soils on uplands. These soils formed in material weathered from loamy shale and sandstone.

In a representative profile the surface layer is very dark brown loam about 10 inches thick. The subsoil is very dark grayish brown, friable loam about 8 inches thick. The underlying material is brown channery loam. Partly weathered sandstone is at a depth of 29 inches.

Sibleyville soils are well drained. Available water capacity and natural fertility are moderate. Permeability is moderate.

Representative profile of Sibleyville loam in an area of Sibleyville complex, 7 to 12 percent slopes, 2,300 feet south and 1,050 feet east of northwest corner of sec. 12, T. 9 S., R. 17 E. in a tame grass pasture:

A1—0 to 10 inches; very dark brown (10YR 2/2) loam; moderate fine and medium granular structure; friable; abundant roots; strongly acid; gradual smooth boundary.

B2t—10 to 18 inches; very dark grayish brown (10YR 3/2) loam and a few sandstone fragments; moderate fine and medium granular structure; friable; medium acid; gradual smooth boundary.

C—18 to 29 inches; brown (10YR 5/3) channery loam; moderate to medium granular structure to massive; friable; medium acid; abrupt wavy boundary.

R—29 inches; partly weathered, brown fine grained sandstone.

Depth to sandstone or loamy shale ranges from 24 to 40 inches. The A horizon is 6 to 12 inches thick. In some places, it is fine sandy loam. The B horizon is loam or clay loam and is 8 to 20 inches thick.

Sibleyville soils are near Sogn and Vinland soils. They are deeper and contain more sand in all horizons than either Sogn or Vinland soils.

Ss—Sibleyville complex, 3 to 7 percent slopes. This moderately sloping mapping unit occurs on a landscape of convex side slopes and narrow ridges. Areas range from 8 to 220 acres.

This unit is about 60 percent Sibleyville soil; about 25 percent a soil that is similar to the Sibleyville soil but is less than 20 inches deep over sandstone or loamy shale; and about 15 percent a soil that is similar to Sibleyville soil but has a more clayey and thicker subsoil and is more than 40 inches deep over sandstone or loamy shale.

Included in mapping are small areas of Martin, Vinland, Gymer, Shelby, and Pawnee soils and small severely eroded areas, which are identified by spot symbols on the soil map.

Runoff is medium, and the erosion hazard is high. The main concerns of management are controlling erosion and increasing fertility.

About 60 percent of the acreage is cultivated. The rest is used for pasture. The pastured areas are in tame or native grasses. This unit is best suited to grasses. If cultivated, it is better suited to wheat, other small grain, and grain sorghum than to corn or soybeans. Capability unit IVe–2; Loamy Upland range site; pasture suitability group G; not assigned to a woodland suitability group.

Sv—Sibleyville complex, 7 to 12 percent slopes. This strongly sloping mapping unit occurs on convex side slopes and, in some areas, on side slopes below limestone outcrops. Areas range from 10 to 70 acres.

This unit is about 50 percent Sibleyville soil; about 25 percent a soil that is similar to the Sibleyville soil but is less than 20 inches deep over sandstone or loamy shale; and about 15 percent a soil that is similar to the Sibleyville soil but has a more clayey and thicker subsoil and is more than 40 inches deep over loamy shale or sandstone. The Sibleyville soil has the profile described as representative of the series. In most areas the shallow soil and the Sibleyville soil occupy the higher, steeper parts of the landscape, and the deeper soils the lower, less steep parts.

Included in mapping are some small areas of Vinland, Martin, Pawnee, and Gymer soils, and small severely eroded areas, which are identified by spot symbols on the soil map.

Runoff is rapid. The erosion hazard is high where this unit is cultivated or where pasture is overgrazed. The main concern of management is to maintain and improve stands of grass.

Most of the acreage is used for pasture. The soils are best suited to grasses. Only a few small areas are cultivated. Capability unit VIe–1; Loamy Upland range site; pasture suitability group G; not assigned to a woodland suitability group.

Sogn Series

The Sogn series consists of shallow, moderately sloping to moderately steep soils on uplands. These soils formed in material weathered from limestone. Native vegetation is mid and tall prairie grasses.

In a representative profile the surface layer is silty clay loam about 13 inches thick (fig. 8). The upper 9 inches is very dark brown and the lower 4 inches is

Figure 8.—**Profile of Sogn silty clay loam.**

very dark grayish brown. Limestone is at a depth of 13 inches.

Sogn soils are somewhat excessively drained. Available water capacity is very low, and natural fertility is high. Permeability is moderate.

The Sogn soils in Jefferson County are mapped only with Vinland soils.

Representative profile of Sogn silty clay loam in an area of Sogn-Vinland complex, 5 to 20 percent slopes, 1,850 feet east and 500 feet north of southwest corner of sec. 6, T. 11 S., R. 19 E., in native grassland:

A11—0 to 9 inches; very dark brown (10YR 2/2) silty clay loam; strong very fine and fine subangular blocky structure; firm; many fine medium roots; neutral; clear boundary.

A12—9 to 13 inches; very dark grayish brown (10YR 3/2) silty clay loam and a few fragments of limestone; strong very fine and fine subangular blocky structure; firm; common fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

R—13 inches; limestone; numerous vertical cracks and solution channels filled with dark colored soil material.

The A horizon ranges from very dark brown to very dark grayish brown. The limestone ranges from thick, massive layers to thin, broken ledges that are interbedded with shale.

Sogn soils are near Oska, Sibleyville, and Vinland soils. They are shallow over limestone, and Vinland soils are shallow over shale. Sogn soils contain less sand than Sibleyville soils in all horizons. They are not so deep over limestone as Oska soils.

Sw—Sogn-Vinland complex, 5 to 20 percent slopes. This moderately sloping to moderately steep mapping unit is somewhat excessively drained. It is about 55 percent Sogn soil, 30 percent Vinland soil and 15 percent Martin, Oska, and Sibleyville soils. Each soil occurs as a narrow band on the landscape. All formed in material weathered from interbedded shale and limestone. Areas are 100 to 800 feet wide and 500 feet to several miles long.

Runoff is medium to rapid. The main concern of management is to maintain and improve native vegetation.

Most areas are used for pasture. The vegetation is about 50 percent mid and tall native grasses. The rest is a less desirable grass species and woody plants. The soils are not suited to cultivated crops. Capability unit VIe–2; Sogn soil in Shallow Limy range site, Vinland soil in Loamy Upland range site; pasture suitability group H; not assigned to woodland suitability group.

Vinland Series

The Vinland series consists of shallow, moderately sloping to steep soils on uplands. These soils formed in material weathered from silty shale. Native vegetation is tall prairie grasses.

In a representative profile the surface layer is very dark grayish brown silty clay loam about 8 inches thick. The subsoil is dark brown, friable silty clay loam about 4 inches thick. The underlying material is pale brown silty clay loam. Olive brown and yellowish brown weathered shale is at a depth of 16 inches.

Vinland soils are somewhat excessively drained. Available water capacity is low, and natural fertility is moderate. Premeability is moderate.

Representative profile of Vinland silty clay loam in an area of Vinland complex, 7 to 15 percent slopes, 1,950 feet east and 500 feet south from northwest corner sec. 29, T. 10 S., R. 18 E. in native grass:

A1—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate medium and fine granular structure; friable; medium acid; gradual smooth boundary.

B2—8 to 12 inches; dark brown (10YR 4/3) silty clay loam; fine and very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

C—12 to 16 inches; pale brown (10YR 6/3) silty clay loam; highly weathered shale; some visible bedding; massive; firm; neutral.

R—16 inches; olive brown (2.5Y 4/4) and yellowish brown (10YR 5/4) shale; bedded and dense.

Reaction in the solum ranges from medium acid to neutral. Color in the A horizon ranges from very dark grayish brown to very dark brown. Colors in the C horizon are variable and are dark grayish brown, olive brown, or yellowish brown. Depth to the underlying shale ranges from 10 to 20 inches.

Vinland soils are near Martin, Sibleyville, Oska, and Sogn soils. Vinland soils are not so deep as Martin, Oska, and Sibleyville soils, and they lack a B2t horizon. Vinland soils are shallow over shale, whereas Sogn soils are shallow over limestone.

Vc—Vinland complex, 3 to 7 percent slopes. This moderately sloping mapping unit occurs on side slopes, generally below limestone or sandstone formations. It is about 45 percent Vinland soil; about 30 percent a soil that is similar to Vinland soil but is 20 to 40 inches deep over shale and is 30 to 45 percent clay in the surface layer and subsoil; and about 15 percent Martin soil. Areas range from 5 to 120 acres.

Included with this unit in mapping are small areas of Sibleyville, Shelby, Pawnee, Sogn, and Oska soils and small severely eroded areas identified by spot symbols on the soil map.

Runoff is medium, and the erosion hazard is high. The main concerns of management are controlling erosion and increasing fertility.

About 65 percent of the acreage is pastured. The rest is cultivated. This mapping unit is best suited to grasses. If cultivated, it is better suited to wheat and other small grain than to corn or soybeans. Capability unit IVe-3; Loamy Upland range site; pasture suitability group G; not assigned to a woodland suitability group.

Vo—Vinland complex, 7 to 15 percent slopes. This strongly sloping mapping unit is on side slopes below limestone and sandstone formations. Areas occur mostly as bands 200 to 1,000 feet wide and 1,300 feet to 4 miles long. They range from 10 to several hundred acres.

About 40 percent of this unit is Vinland soil and about 30 percent a soil that is similar to the Vinland soil but is 20 to 40 inches deep over shale and is 30 to 45 percent clay in the surface layer and subsoil. The Vinland soil has the profile described as representative of the series.

Included with this unit in mapping are small areas of Martin, Pawnee, Gymer, Shelby, Sibleyville, and Sogn soils and small severely eroded areas, which are identified by spot symbols on the soil map.

Runoff is rapid. The erosion hazard is high in cultivated areas or where pasture is overgrazed. The main concern of management is to maintain and improve the stands of grass.

Most of the acreage is used for pasture. The grasses are tame or native. In some native grass areas, woody vegetation makes up a large part of the plant cover. A few areas are cultivated. This unit is best suited to grasses. Capability unit VIe-1; Loamy Upland range site; pasture suitability group G; not assigned to a woodland suitability group.

Vx—Vinland-Rock outcrop complex, 20 to 40 percent slopes. This steep mapping unit occurs on side slopes on uplands. It consists of shallow soils intermingled with deeper soils and Rock outcrop.

This mapping unit is about 55 percent Rock outcrop, about 30 percent Vinland soil, and 15 percent Martin, Gymer, Pawnee, Sogn, and Oska soils. The rock outcrop is dominantly limestone and sandstone. Flaggy and stony limestone fragments occur on the surface of other soils, generally near and down slope from the bedrock outcrop. The Vinland soil has a profile similar to the one described as representative of the series, but in some places the surface is flaggy or stony.

Available water capacity is generally low. Runoff is very rapid.

Most of the acreage is used for pasture. A few acres are used for wildlife and recreation. Most of the vegetation is of the woody type, but some is annual plants and mid and tall prairie grasses. Capability unit VIIe-1; Breaks range site; pasture suitability group H; not assigned to a woodland suitability group.

Wabash Series

The Wabash series consists of deep, nearly level soils on bottom land and terraces. These soils formed in clayey alluvium. Native vegetation is water-tolerant prairie grasses and a few deciduous trees.

In a representative profile the surface layer is black silty clay loam about 19 inches thick. The subsoil is very dark gray and grayish brown very firm silty clay about 24 inches thick. The underlying material is dark gray and dark grayish brown heavy silty clay loam.

Wabash soils are poorly drained to very poorly drained. Available water capacity and natural fertility are high. Permeability is very slow.

Representative profile of Wabash silty clay loam, 1,800 feet east, 150 feet north of southwest corner of sec, 23, T. 11 S., R. 18 E. in cultivated field:

Ap—0 to 6 inches; black (10YR 2/1) silty clay loam; weak fine granular structure; friable; common fine roots; slightly acid; abrupt smooth boundary.

A12—6 to 19 inches; black (10YR 2/1) heavy silty clay loam; moderate fine and very fine subangular blocky structure; firm; few fine dark gray (10YR 4/1) mottles; a few worm casts; medium acid; gradual smooth boundary.

B2g—19 to 38 inches; very dark gray (10YR 3/1) silty clay; moderate medium blocky structure; few fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; very firm; few fine black concretions; medium acid; diffuse smooth boundary.

B3g—38 to 43 inches; grayish brown (10YR 5/2) silty clay; weak medium subangular blocky structure; common fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; very firm; few fine black concretions; slightly acid; diffuse smooth boundary.

C—43 to 80 inches; dark gray (10YR 4/1) and dark grayish brown (10YR 4/2) heavy silty clay loam; weak coarse blocky structure; common fine faint and distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; firm; few fine black concretions; slightly acid.

The A horizon ranges from silty clay to silty clay loam. The B horizon is silty clay or clay. The A horizon and upper part of the B horizon range from medium acid to neutral. The lower part of the B horizon and the entire C horizon range from slightly acid to mildly alkaline and in places contain a few calcium carbonate concretions.

Wabash soils occur near Reading and Kennebec soils and in similar positions as Kimo soils. Wabash soils are more clayey throughout than Reading and Kennebec soils. They are clayey to a depth of more than 40 inches, whereas, Kimo soils have a loamy C horizon at a depth of less than 40 inches.

Wc—Wabash silty clay loam. This nearly level soil occurs on flood plains and terraces along streams. It has the profile described as representative of the series. Slopes are 0 to 1 percent slopes. Areas range from 4 to 940 acres.

Included with this soil in mapping are small areas of Wabash silty clay and areas of Reading and Kennebec soils.

Runoff is very slow. The hazard of wetness is moderate. The main concern of management is the removal

of excess water that this soil often receives from adjacent uplands and streams. Drainage is needed in some areas where the surface is slightly depressional.

Most of the acreage is cultivated. A few areas are pastured. All crops commonly grown in the county are well suited. Capability unit IIw–3; Clay Lowland range site; pasture suitability group E; woodland suitability group 4w.

Wh—Wabash silty clay. This nearly level soil occurs on second bottoms and terraces along the larger streams. It has a profile similar to the one described as representative of the series, but the surface layer is a silty clay. Slopes are 0 to 1 percent. Areas range from 4 to 200 acres.

Included with this soil in mapping are small areas of Wabash silty clay loam and areas of Judson and Reading soils.

Runoff is very slow to ponded. Flooding is rare to occasional. The hazard of wetness is high. The main concern of management is the removal of excess surface water. Because the surface layer is sticky and plastic when wet and hard when dry, this soil is difficult to cultivate.

Most of the acreage is cultivated. A few areas are pastured. Soybeans, grain sorghum, and wheat are better suited than corn or alfalfa. Capability unit IIIw–1; Clay Lowland range site; pasture suitability group E; woodland suitability group 4w.

Planning the Use and Management of the Soils

The soil survey is a detailed analysis and evaluation of the most basic resource of the survey area—the soil. It may be used to fit the use of the land, including urbanization, to the limitations and potentials of the natural resources and the environment and to help avoid soil-related failures in uses of the land.

During a soil survey soil scientists, conservationists, engineers, and others keep extensive notes, not only about the nature of the soils but also about unique aspects of behavior of these soils in the field and at construction sites. These notes include observation of erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic systems, and other factors relating the kinds of soil and their productivity, potentials, and limitations under various uses and management. In this way field experience incorporated with measured data on soil properties and performance is used as a basis for predicting soil behavior.

Information in this section will be useful in applying basic facts about the soils to plans and decisions for use and management of soils for crops and pasture, range, woodland, and many nonfarm uses, including building sites, highways and other transportation systems, sanitary facilities, parks and other recreational developments, and wildlife habitat. From the data presented, the potential of each soil for specified land uses may be determined, soil limitations to these land uses may be identified, and costly failures in homes and other structures, because of unfavorable soil properties, may be avoided. A site can be selected where the soil properties are favorable, or practices can be planned that will overcome the soil limitations.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area, and on the environment. Both of these factors are closely related to the nature of the soil. Plans can be made to maintain or create a land use pattern in harmony with the natural soil.

Contractors can find information useful in locating sources of sand and gravel, road fill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, trees and shrubs, and most other uses of land are influenced by the nature of the soil.

Crops[3]

About 38 percent of Jefferson County is cultivated (*11*). Soybeans, grain and forage sorghum, corn for both grain and forage, and small grain are the chief cultivated crops. Alfalfa, sweetclover, vetch, sudangrass, lespedeza, and red clover are grown for forage or cover. Most of the alfalfa used to make dehydrated products is grown in the Kansas River Valley.

The loamy soils in the Kansas River Valley are well suited to most vegetables. In addition, they are well suited to irrigation, and water is available. Only a few acres, however, are irrigated.

Good management maintains and improves the productivity of the soil. The main considerations in managing cultivated soils in the county are maintaining fertility, controlling erosion, and making the most efficient use of available water.

Fertility can be maintained by controlling erosion, adding commercial fertilizer and barnyard manure, and managing crop residue. The kind and amount of fertilizer for each crop is determined by field trials, farmer experience, and soil tests.

Terracing, contour farming, crop residue management, timely tillage, and minimum tillage help in controlling erosion. Terracing and contour farming can reduce water erosion and conserve rainfall on all sloping soils in the county. Erosion control is also beneficial where slopes are long and smooth. Each row planted on the contour provides a miniature terrace by holding back water and letting it soak into the soil. The water that is saved by terracing and contour farming increases crop growth, which in turn adds to the amount of residue available to protect the soil.

Good management of crop residue applies to all the soils in Jefferson County. Good management of crop residue maintains soil structure, increases infiltration of water, and helps control both water erosion and soil blowing. A cover of residue on the surface holds the

[3] EARL J. BONDY, conservation agronomist, Soil Conservation Service, helped prepare this section.

soil in place and reduces puddling effect of beating raindrops.

Minimum tillage is only the amount of tillage needed to break up a surface crust, to control weeds, or to prepare a seedbed. Minimum tillage prevents the breakdown of soil aggregates and maintains more residue on the surface.

Stripcropping can be used in control of soil blowing. It is generally used in combination with a good crop residue management program, minimum tillage, and a good fertility program. Stripcropping is especially applicable to some of the nearly level soils that have a fine sandy loam or coarse silt loam surface layer.

For further information about crop management, consult the local representative of the Soil Conservation Service or the Extension Service.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of crops. The groups are made according to the limitations of the soils when used for farming, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or engineering.

In the capability system all kinds of soils are grouped at three levels: The capability class, the subclass, and the unit. These levels are defined in the following paragraphs:

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils (none in the county) are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.

Class VIII soils and landforms (none in the county) have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-1 or IIIe-2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass or kind of limitation as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass. For complete explanation of capability classification, see Agriculture Handbook No. 210, Land Capability Classification (*19*).

Management by capability units

The use and management of soils by capability units is suggested on the pages that follow. The names of the soil series represented are mentioned in the description of each unit, but this does not mean that all the soils of a given series are in the unit. The capability unit for each soil in the county is designated in the Guide to Mapping Units at the back of this survey.

CAPABILITY UNIT I-1

This unit consists of deep, nearly level soils of the Judson and Reading series. These are well drained or moderately well drained silty soils in stream valleys that are not subject to damaging overflow.

These soils are easily tilled. They have high available water capacity and high natural fertility. Permeability is moderate or moderately slow.

All crops commonly grown in this county grow well on these soils, including field and vegetable crops, grasses, and trees. Minimum tillage, good management of crop residue, and adequate commercial fertilizer are needed to maintain fertility and tilth and the supply of organic matter. A crop rotation helps control weeds and insects.

CAPABILITY UNIT IIe-1

The unit consists of deep, nearly level and gently sloping soils of the Grundy, Martin and Pawnee series. These are somewhat poorly drained and moderately well drained soils on uplands. The surface layer is silty clay loam or clay loam, and the subsoil is silty clay or clay.

These soils have high available water capacity and high natural fertility. Permeability is slow. Erosion is a slight hazard.

All cultivated crops commonly grown in the county are suited. Tame and native grasses also grow well. Minimum tillage, terracing and contour farming, good management of crop residue, and adequate commercial fertilizer are needed to maintain fertility and tilth and the supply of organic matter. They are also needed for erosion control.

CAPABILITY UNIT IIw-1

This unit consists of deep, nearly level to gently undulating soils of the Kimo and Eudora series. These are somewhat poorly drained to well drained soils in the Kansas River Valley. They have a silt loam or silty clay loam surface layer.

These soils have high available water capacity and high natural fertility and are easy to till. Permeability is moderate to slow. Wetness or ponding in low areas after periods of excessive rainfall and soil blowing in some areas of Eudora soils are the only management problems. Flooding is rare but damaging.

All crops commonly grown in this county grow well on these soils, including field and vegetable crops. Grasses and trees also grow well. Minimum tillage, good management of crop residue, and adequate commercial fertilizer are needed to maintain fertility and tilth and the supply of organic matter. Stripcropping is suggested in areas where soil blowing is a problem. A crop rotation helps control weeds and insects. Ditches and land leveling are needed for drainage.

CAPABILITY UNIT IIw-2

Kennebec silt loam, the only soil in this unit, is a nearly level, deep, well drained or moderately well drained soil on bottom land. It has a silt loam surface layer.

This soil is easy to till. It has high natural fertility and available water capacity. Permeability is moderate. The major hazard is the damage to crops by floods.

This soil is suited to all cultivated crops commonly grown in the county. Tame and native grasses and trees also grow well.

Minimum tillage, good management of crop residue, and adequate commercial fertilizer are needed to maintain fertility and tilth and the supply of organic matter. Protecting crops from flooding generally is not feasible.

CAPABILITY UNIT IIw-3

The unit consists of deep, nearly level soils of the Wabash and Kimo series. These somewhat poorly drained to very poorly drained soils are on high flood plains and low terraces along streams. The surface layer is silty clay loam and the subsoil is silty clay.

These soils have high natural fertility and available water capacity. Permeability is slow and very slow. Wetness caused by runoff from surrounding higher areas and flooding from large streams is the main management problem. The Kimo silty clay loam occurs along the Kansas River where the water table is high during periods of high flow.

These soils are suited to all cultivated crops commonly grown in the county. Tame and native grasses and trees also grow well.

Minimum tillage, crop rotation, good management of crop residue, and adequate commercial fertilizer are needed to maintain fertility and tilth and the supply of organic matter. Diversion terraces and terraces constructed in adjacent upland areas are needed to keep water from running onto these soils. Also, drainage ditches and land leveling may be needed in some areas.

CAPABILITY UNIT IIs-1

The only soil in this unit is Haig silty clay loam. This nearly level upland soil is deep and somewhat poorly drained. It has a thin silty clay loam surface layer and a dense silty clay subsoil.

This soil is high in natural fertility and available water capacity. Wetness, caused by very slow permeability and slow runoff, makes tillage and harvest difficult during periods of excessive rainfall. In dry years this soil is droughty. The erosion hazard is slight.

This soil is suited to cultivated crops commonly grown in the county. Tame and native grasses also grow well.

Minimum tillage, good management of crop residue, and an adequate and timely application of commercial fertilizer are needed to maintain fertility and tilth and the supply of organic matter. A crop rotation is desirable. During some years, fall tillage is needed in order to prepare a desirable seedbed for early planting of crops.

CAPABILITY UNIT IIIe-1

This unit consists of deep and moderately deep, moderately sloping soils of the Oska, Shelby, Morrill, and Gymer series. These are well drained or moderately well drained upland soils. The surface layer is clay loam, loam, silt loam, or silty clay loam, and the subsoil is clay loam, silty clay loam, or light silty clay.

These soils are easily tilled. They have high natural fertility and moderate or high available water capacity. Permeability is slow or moderately slow. The erosion hazard is moderate to high in cultivated or overgrazed areas, but only slight on well managed grassland.

The soils of this unit are suited to all cultivated crops commonly grown in the county. They are well suited to tame and native grasses. Some areas of Gymer silt loam, 3 to 7 percent slopes, are suited to trees.

Minimum tillage, crop rotation, good management of residue, and adequate commercial fertilizer are needed to maintain fertility and tilth and the supply of organic matter. Terracing and contour farming are needed for erosion control.

CAPABILITY UNIT IIIe-2

This unit consists of deep, moderately sloping soils of the Grundy, Martin, and Pawnee series. These soils are moderately well drained and somewhat poorly drained upland soils that have a silty clay loam or clay loam surface layer and a silty clay or clay subsoil.

These soils have high available water capacity and high natural fertility. Permeability is slow. The erosion hazard is high in cultivated or overgrazed areas, but only slight on well managed grassland.

The soils are suited to all cultivated crops commonly grown in the county. Tame and native grasses also grow well.

Minimum tillage, crop rotation, good management of crop residue, and adequate commercial fertilizer are needed to maintain fertility and tilth and the supply of organic matter. Terracing and contour farming are needed for erosion control.

CAPABILITY UNIT IIIw-1

Wabash silty clay, the only soil in this capability unit, is deep, nearly level, and very poorly drained. It is on large high flood plains along major streams in the county.

This soil has high natural fertility and available water capacity. A high clay content makes cultivation difficult. During dry periods, this soil shrinks and many deep cracks form, especially when alfalfa is grown. The high clay content also restricts permeability. Surface runoff is very slow to ponded. In addition, runoff from surrounding higher areas and proximity to large streams result in occasional flooding. Surface drainage is slow. Crops are sometimes drowned out.

Soybeans, wheat, and grain sorghum are better suited to this soil than corn. Water-tolerant grasses are also well suited. This soil can be managed for wetland wildlife habitat.

Excess water removal is the main management problem. A bedding system helps remove some of the water. Diversion terraces and terraces constructed on adjacent upland areas control runoff. A crop rotation and good management of crop residue improve tilth. Adequate and timely application of commercial fertilizer is needed to maintain fertility. Tilling in fall may provide a more desirable seedbed.

CAPABILITY UNIT IIIw-2

Only Sarpy-Eudora complex, overwash, is in this capability unit. These nearly level soils are on flood plains along the Kansas River. They are deep and well drained to excessively drained and are sandy or silty throughout.

The soils have low to high available water capacity and are easy to till. Natural fertility is high. The supply of organic matter is moderately low to low. Soil blowing is a moderate hazard. Flooding is rare but damaging.

All crops commonly grown in this county grow well on these soils, including field and vegetable crops, grasses, and trees. Minimum tillage, green manure crops, adequate commercial fertilizer, and good management of crop residue are needed to maintain fertility and the supply of organic matter. Stripcrops and winter cover crops are needed for control of soil blowing.

CAPABILITY UNIT IVe-1

Only Konawa complex, 4 to 10 percent slopes, is in this unit. It is deep and well drained and is sandy and loamy throughout.

Permeability is moderate to rapid. Natural fertility is moderate, and available water capacity ranges from moderate to high. The erosion hazard is high.

These soils are best suited to grasses and trees, but are suited to wheat, oats, and grain sorghum. Corn and soybeans grow well in some areas.

Minimum tillage, crop rotation, good management of crop residue, and adequate commercial fertilizer are needed in cultivated areas. Also, terracing and contour farming are needed for control of erosion.

CAPABILITY UNIT IVe-2

Only Sibleyville complex, 3 to 7 percent slopes, is in this unit. It is well drained, is shallow to moderately deep, and is loamy throughout.

Permeability is moderate. Available water capacity is low to moderate. Natural fertility is moderate. The erosion hazard is high.

The soils of this unit are best suited to tame and native grasses, but are suited to wheat and other small grain. Minimum tillage, crop rotation, good management of crop residue, and adequate commercial fertilizer are needed in cultivated areas. Also, terracing and contour farming are needed for erosion control.

CAPABILITY UNIT IVe-3

This unit consists of soils of the Martin, Oska, and Vinland series. The soils are moderately well drained to somewhat excessively drained and are shallow, moderately deep, and deep. Slopes are 3 to 7 percent. The surface layer is silty clay loam, and the subsoil is silty clay loam or silty clay.

These soils have high to moderate natural fertility. Available water capacity is low to high. Permeability is slow to moderate. The areas of shallow soils make this unit difficult to cultivate. The erosion hazard is high.

The soils of this unit are best suited to tame and native grasses, but are suited to wheat and other small grain and to grain sorghum. Minimum tillage, crop rotation, good management of crop residue, and adequate commercial fertilizer are needed to maintain fertility and tilth and the supply of organic matter. Terracing and contour farming are needed in cultivated areas.

CAPABILITY UNIT IVe-4

This unit consists of deep, moderately sloping, eroded soils of the Martin and Pawnee series. These are moderately well drained clayey soils on uplands.

These soils have a low organic-matter content and are difficult to till. They have high natural fertility

and available water capacity. Permeability is slow. The erosion hazard is high.

These soils are suited to wheat or other small grain, but are better suited to tame and native grasses.

Minimum tillage, green manure crops, good management of crop residue, and adequate commercial fertilizer are needed if these soils are cultivated. Terracing and contour farming are needed for erosion control.

CAPABILITY UNIT IVe-5

Only Shelby-Pawnee complex, 8 to 12 percent slopes, is in this unit. These soils are deep and well drained to moderately well drained. The surface layer is loam or clay loam, and the subsoil is clay loam or clay.

These soils have high natural fertility and available water capacity. Permeability is moderately slow and slow. The erosion hazard is high.

These soils are well suited to tame and native grasses and are suited to wheat and other small grain. Minimum tillage, crop rotation, good management of crop residue, and adequate commercial fertilizers are needed in cultivated areas. Also, terracing and contour farming are needed for erosion control.

CAPABILITY UNIT VIe-1

This unit consists of strongly sloping soils of the Sibleyville and Vinland series. These are shallow, moderately deep, and deep soils on uplands. They are moderately well drained to somewhat excessively drained. The surface layer is loam to silty clay loam, and the subsoil is loam to silty clay. The erosion hazard is high.

These soils are well suited to tame and native grasses. They are not suited to cultivated crops.

Maintaining and improving the grasses are the chief management needs. Renovating the grasses is practical in some areas, depending on the amount of woody vegetation.

CAPABILITY UNIT VIe-2

Only Sogn-Vinland complex, 5 to 20 percent slopes, is in this capability unit. These are shallow silty clay loams that are somewhat excessively drained. The available water capacity is very low and low. Natural fertility is moderate to high.

These soils are best suited to native grasses. Establishing tame grasses is possible, but is generally not economically feasible. The soils are not suited to cultivated crops. Maintaining and improving the grasses are the chief management needs.

CAPABILITY UNIT VIw-1

Only Kennebec soils, channeled, is in this unit. These moderately well drained to well drained, deep loamy soils are on narrow flood plains cut by meandering stream channels. They have high available water capacity and high natural fertility. Flooding is frequent.

These soils are well suited to trees and grasses. Because of flooding and inaccessibility, they are not suited to cultivated crops. Maintaining and improving the grasses and the production of wood crops are the chief management needs.

CAPABILITY UNIT VIIe-1

Only Vinland-Rock outcrop complex, 20 to 40 percent slopes, is in this unit. It consists of shallow and moderately deep soils and many rock outcrops. It is excessively drained.

Most of the acreage is used for grazing or wildlife habitat. The vegetation is native prairie grasses and trees. Trees are not well suited. The wood product is mostly firewood.

Careful management is needed to protect and to increase the native prairie grasses. Pasture renovation is impractical.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 2. In any given year, yields may be higher or lower than those indicated in table 2 because of seasonal variations in rainfall and other climatic factors. Absence of a yield estimate indicates that the crop is not suited to the specified soil, is not commonly grown on the soil, or is not commonly irrigated.

The predicted yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The latest soil and crop management used by many farmers in the county is assumed in predicting the yields. Yields of hay and pasture are predicted for varieties of grasses and legumes suited to the soil.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage and erosion control; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; harvesting crops with the smallest possible loss; and timely fieldwork.

The predicted yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase in the future as new production technology is developed. The productivity of a given soil as compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 2 are grown in the survey area, but because their acreage is small, predicted yields for these crops are not included. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the productivity and management concerns of the soils for these crops.

Pasture[4]

About 42 percent of Jefferson County is grassland (*11*). Of this acreage about 18 percent, or about 62,000 acres, is in cool-season tame grasses, such as smooth

[4] EARL J. BONDY, conservation agronomist, Soil Conservation Service, helped prepare this section.

TABLE 2.—*Yields per acre of crops and pasture*

[All yields were estimated for a high level of management in 1974. Absence of a yield figure indicates the crop is seldom grown or is not suited]

Soil name and map symbol	Corn	Grain sorghum	Soybeans	Winter wheat	Alfalfa hay	Smooth bromegrass
	Bu	*Bu*	*Bu*	*Bu*	*Ton*	*AUM*[1]
Eudora:						
[2] Ec	105	105	45	47	5.4	6.5
Grundy:						
Gb	90	88	36	42	4.3	6.0
Gc	86	85	34	40	3.7	6.0
Gymer:						
Gy	80	90	35	41	4.1	6.1
Haig:						
Hc	65	75	24	34	3.5	5.0
Judson:						
Ju	110	111	44	52	6.0	---
Kennebec:						
Kb	96	98	40	42	5.5	6.0
[2] Kc	---	---	---	---	---	6.0
Kimo:						
Km	80	90	38	40	4.5	---
[2] Ko	88	94	40	40	4.8	---
Konawa:						
[2] Kv	67	74	28	36	---	---
Martin:						
Mb	80	85	35	40	3.9	5.5
Mc	75	80	31	38	3.6	5.5
[2] Mh	50	59	24	26	2.6	4.5
[2] Mo	55	58	26	30	3.0	5.5
Morrill:						
Mv	85	90	35	41	4.0	6.5
Oska:						
Oc	67	70	28	36	3.4	5.5
Pawnee:						
Pb	80	85	34	40	4.0	5.5
Pc	72	80	30	38	3.7	5.5
[2] Ph	51	61	23	26	2.6	4.5
Reading:						
Re	103	106	44	50	5.6	7.0
Sarpy:						
[2] Sb	70	80	30	35	5.2	---
Shelby:						
[2] Sc	84	88	33	40	4.5	6.0
[2] So	68	75	28	37	---	6.0
Sibleyville:						
[2] Ss	55	65	22	32	3.5	5.4
[2] Sv	---	---	---	---	---	5.0
Sogn:						
[2] Sw	---	---	---	---	---	---
Vinland:						
Vc	48	55	23	27	2.2	4.5
[2] Vo, [2] Vx	---	---	---	---	---	3.0
Wabash:						
Wc	85	90	38	40	4.5	6.5
Wh	63	70	30	34	3.5	---

[1] Animal-unit-month: The amount of forage or feed required to feed one animal unit (One cow, one horse, one mule, five sheep, or five goats) for a period of 30 days.

[2] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

brome, tall fescue, reed canarygrass, and orchardgrass (*11, 21*). These areas of tame grass occur throughout the county. Some are entirely tame grasses, and others are tame and native grasses.

The main considerations in managing these areas of grass are maintaining or improving the quality and quantity of forage, providing soil protection, and reducing water loss. Leaf development, root growth, flower-stalk formation, seed production, forage regrowth, and food storage in roots are processes in the development and growth of grass. All are essential if maximum yields of forage are to be maintained.

The management needed to maintain a good stand of tame grasses is described in the following paragraphs.

Proper stocking rate.—Adjust the numbers of livestock to the expected yield. Forage and feed are provided for livestock for the entire season. As a guide, farmers can allow 40 pounds of forage per mature cow per day for continuous seasonal grazing or 35 pounds per mature cow per day for rotation grazing.

Grazing management.—Delay grazing in the spring until the soil is dry and firm to prevent trampling and compacting damage. Grasses are given a rest from grazing during their mid-summer dormancy. When rotation grazing is practiced, the farmer provides an adequate number of pastures with sufficient acreage in ratio to the number of livestock to allow the grasses to make a satisfactory recovery between each grazing.

Water and salt.—Provide adequate water and salt at enough locations to result in uniform grazing of livestock.

Fertilizing.—Apply the kind and amount of fertilizers according to the results of soil test, field observation, and experience.

Mowing and controlling unwanted vegetation.—Mow if pasture is grazed unevenly or there is an excess of forage. Mowing grasses and spraying with herbicides controls invading trees, brush, low quality grass, and broadleaved weeds.

Pasture suitability groups

Described on the following pages are groups of soils that have similar potential for producing tame grasses. The predicted yield of total air-dry forage is given for each group when soils are well managed, adequately fertilized, and receive average rainfall. To determine the soils that make up each suitability group, refer to the Guide to Mapping Units at the back of this survey.

PASTURE SUITABILITY GROUP A–1

This group consists of nearly level soils on bottom land. These soils have a loamy surface layer and subsoil. They are well drained to moderately well drained. They have high available water capacity and high natural fertility. Eudora, Kennebec, Judson, and Reading soils are in this group.

Smooth brome, tall fescue, and orchardgrass are well suited. When the soils are well managed and rainfall is average, the expected annual yield of air-dry forage is about 7,500 to 9,000 pounds per acre.

PASTURE SUITABILITY GROUP A–2

This group consists of gently sloping to strongly sloping soils on upland. These soils have a loamy surface layer and a loamy and clayey subsoil. They are well drained to somewhat poorly drained. They have high natural fertility and moderate to high available water capacity. Grundy, Gymer, Martin, Morrill, Oska, Pawnee, and Shelby soils are in this group.

Smooth brome, tall fescue and orchardgrass are suited. Reed canarygrass grows well in some areas. When the soils are well managed and rainfall is average, the expected annual yield of air-dry forage is about 7,000 to 8,500 pounds per acre.

PASTURE SUITABILITY GROUP B

This group consists of nearly level to strongly sloping, sandy and loamy soils. These soils are somewhat excessively drained to excessively drained. They have low to moderate available water capacity and moderate to high natural fertility. Sarpy and Konawa soils are in this group.

Smooth brome, tall fescue and orchardgrass are suited. When the soils are well managed and rainfall is average, the expected annual yield of air-dry forage is about 5,500 to 7,000 pounds per acre.

PASTURE SUITABILITY GROUP C

This group consists of nearly level to moderately sloping soils on uplands. These soils have a loamy and clayey surface layer and a clayey subsoil. They are somewhat poorly drained to moderately well drained. Available water capacity is high, and natural fertility is high. Haig soils and the eroded Martin and Pawnee soils are in this group.

Tall fescue, smooth brome and reed canarygrass are suited. When the soils are well managed and rainfall is average, the expected annual yield of air-dry forage is about 4,500 to 6,000 pounds per acre.

PASTURE SUITABILITY GROUP E

The nearly level soils of this group are on bottom land. They have a loamy and clayey surface layer and a clayey subsoil. These soils are somewhat poorly drained to very poorly drained. They receive additional moisture from the runoff of nearby uplands and from flooding. They have high natural fertility and available water capacity. Kimo and Wabash soils are in this group.

Reed canarygrass, tall fescue, and smooth brome are suited. When the soils are well managed and rainfall is average, the expected annual yield of air-dry forage is about 5,500 to 7,500 pounds per acre.

PASTURE SUITABILITY GROUP G

This group consists of moderately sloping to strongly sloping soils on uplands. These soils range from shallow to deep. They have a loamy surface layer and a loamy to clayey subsoil. They are well drained to somewhat excessively drained. Natural fertility is moderate. Available water capacity is low to moderate. Sibleyville and Vinland soils are in this group.

Smooth brome, tall fescue, and orchardgrass are suitable tame grasses. Some areas of the Vinland complex, 7 to 15 percent slopes, can feasibly be cleared of trees and seeded to tame grasses. When the soils are well managed and rainfall is average, the expected

annual yield of air-dry forage is about 4,500 to 6,000 pounds per acre.

PASTURE SUITABILITY GROUP H

The moderately sloping to steep soils of this group are on uplands. These soils are shallow over limestone or shale. They have a silty clay loam surface layer. They are somewhat excessively drained. Natural fertility is moderate to high. Available water capacity is very low to low. Sogn and Vinland soils are in this group.

The soils are generally not seeded to tame grass because of the difficulty in establishing and maintaining a good stand. Smooth brome, tall fescue, or orchardgrasses are suited to areas where seeding to tame grass is feasible.

Range[5]

Approximately 24 percent of Jefferson County, or 86,000 acres, is range (*11*). Some of the range is mowed annually for native hay production. About 15 percent of the acreage is producing near its potential. The rest is supporting less desirable grasses, trees, shrubs, and broadleaf weeds and producing much below the potential in livestock forage.

Large areas that once supported a plant community chiefly of tall warm-season grasses, including big bluestem, indiangrass, little bluestem, and switchgrass, now support an abundance of less desirable cool-season grasses, such as Kentucky bluegrass, Scribner panicum, and sedges. These areas are locally referred to as "bluegrass pastures." This change is the result of overgrazing year after year during the summer when warm-season plants are growing. Gradually the warm-season plants are weakened and are replaced by cool-season plants, which grow mostly early in spring or late in fall. Trees and brush have invaded the grassland where it has been overgrazed.

Grazing management is needed if these areas of range are to be restored. Control of brush may be needed if woody species are seriously competing with grasses for sunlight and moisture.

Range sites and condition classes

Management of range requires knowledge of the soils, the combinations of plants that can be produced, and the effects of grazing on the different kinds of plants.

There are many differences in the soils and the climate of Jefferson County. For this reason, different kinds of range, or range sites, are recognized.

Over the centuries, a mixture of plants best adapted to each range site has developed. This group of plants is called the potential or climax plant community for the site. The climax plant community differs slightly from year to year, but the kinds and amounts of plants remain about the same if the site is well managed.

The original mixture of plants is so well suited to the soil and the climate of the range site that other kinds of plants cannot invade unless the site is disturbed. So consistent is the relation between plants, climate, and soils that the climax plant community can be accurately predicted if the soil and climate are identified.

Repeated overgrazing or plowing results in changes in kinds, proportions, or amounts of climax plants in the plant community. Depending on the kind and degree of disturbance, some plants increase and others decrease. If disturbance is severe, plants that are not part of the climax plant community may invade. Plant response to grazing depends on the kind of grazing animal, the season of use, and how closely the plant is grazed. Under good management, the climax plant community is gradually reestablished on disturbed sites unless the soils have been seriously eroded.

Range condition is a term that compares the present plant community with the climax plant community for the range site. The more nearly the present kinds and amounts of plants are like the climax plant mixture, the better the range condition.

Range condition provides an index to changes that have taken place in the plant community. More important, range condition is a basis for predicting the kind and amount of change in the present plant community that can be expected under planned range management. Thus, the range condition indicates the nature of the present plant community, whereas the climax cover for the range site represents a goal toward which range management can be directed.

To indicate the degree to which the vegetation on a range site has deteriorated from its potential, four classes of range condition are recognized. Range condition is *excellent* if 76 to 100 percent of the present vegetation is of the same composition as the original, or climax, vegetation for the site; *good* if the percentage is 51 to 75; *fair* if 26 to 50; and *poor* if less than 25.

Knowledge of the climax plant community and the present plant community as related to the potential is important in management planning. Such information is the basis for selecting management objectives, designing grazing systems, managing for wildlife, determining potential for recreation, and rating watershed conditions.

Any management objective on range must provide a plant cover that adequately protects or improves the soil and water resources and meets the needs of the operator. It usually involves maintaining or increasing desirable plants and restoring a degraded plant community to near climax condition. Sometimes, however, a plant cover somewhat below climax is more suitable for specific grazing needs, provides better wildlife habitat, or furnishes other benefits and still protects soil and water resources.

On the following pages, the range sites of Jefferson County are described and the climax plants are listed for each site. Plant species most likely to invade are also mentioned. In addition, an estimate of the potential annual production of air-dry vegetation is indicated for each site. The range site for each soil in the county is listed in the Guide to Mapping Units at the back of this soil survey.

[5] HARLAND E. DIETZ, range conservationist, Soil Conservation Service, prepared this section.

BREAK RANGE SITE

This steep site is on uplands. The soil is shallow over limestone and shale. Vinland-Rock outcrop complex, 20 to 40 percent slopes, is the only mapping unit on this range site.

The climax plant community is approximately—

	Percent composition by weight
Side-oats grama	25
Little bluestem	25
Plains muhly	10
Big bluestem	10
Switchgrass	5
Tall dropseed	5
Fall witchgrass	5
Jersey-tea	5
Prairie-clover	5
Woody plants	5

Continuous overgrazing causes changes in the climax plant community. The more preferred plants, chiefly big bluestem, little bluestem, plains muhly, switchgrass, and Jersey-tea, are selectively grazed by livestock. If repeatedly overgrazed, these plants are weakened and gradually decrease in abundance. Less preferred plants, such as side-oats grama, tall dropseed, and western ragweed, increase.

If the site is overgrazed for many years, the vegetation often degenerates to predominantly Kentucky bluegrass, annual bromegrass, silver bluestem, western ragweed, annual broomweed, and woody plants.

If this site is in excellent condition, the average annual yield of air-dry herbage is 4,000 pounds per acre in years of favorable moisture and 2,000 pounds per acre in years of unfavorable moisture.

CLAY LOWLAND RANGE SITE

This site is on bottom land. The soils are nearly level to slightly depressional, deep, and somewhat poorly drained to very poorly drained. They receive additional moisture during periods of flooding. Typically they have a silty clay loam or silty clay surface layer and a silty clay subsoil. The subsoil is slowly to very slowly permeable and impedes root penetration. Available water capacity is high. Kimo and Wabash soils are on this site.

The climax plant community is approximately—

	Percent composition by weight
Prairie cordgrass	30
Eastern gamagrass	15
Big bluestem	15
Indiangrass	10
Switchgrass	5
Canada wildrye and Virginia wildrye	5
Tall dropseed	3
Carex	2
Maximilian sunflower	5
Woody plants	10

Under prolonged overgrazing, the taller grasses, chiefly prairie cordgrass, eastern gamagrass, big bluestem, indiangrass, and switchgrass, decrease in amount. Such plants as side-oats grama, carex, and tall dropseed increase in abundance. Palatable forbs, such as maximilian sunflower, wholeleaf rosinweed, and Illinois bundleflower, also decrease when the site is subjected to continuous overgrazing. Louisiana sagewort, Baldwin ironweed, western ragweed, and tall goldenrod occur in the climax plant community in only minor amounts, but increase rapidly when the site is overgrazed. If the site has been overgrazed for many years, the vegetation is predominantly bluegrass, seacoast sumpweed, tall goldenrod, and tall dropseed.

Woody plants occur on the site and increase in abundance with overgrazing. Common woody species are oak, elm, cottonwood, ash, and hackberry.

If this site is in excellent condition, the average annual yield of air-dry herbage is 9,000 pounds per acre in years of favorable moisture and 5,000 pounds per acre in years of unfavorable moisture.

CLAY UPLAND RANGE SITE

This site is on uplands. The soils are nearly level to moderately sloping and have a thin loamy or clayey surface layer and a clayey subsoil. They have a high available water capacity and are slowly or very slowly permeable. When rainfall is below normal, they are droughty. Haig soils and the eroded Martin and Pawnee soils are on this site.

The climax plant community is approximately—

	Percent composition by weight
Big bluestem	25
Little bluestem	20
Indiangrass	15
Switchgrass	15
Side-oats grama	5
Tall dropseed	5
Compassplant	5
Leadplant	5
Missouri goldenrod	3
Western ragweed	2

Continuous overgrazing causes changes in the climax plant community. The more preferred plants, chiefly big bluestem, little bluestem, indiangrass, switchgrass, compassplant, and leadplant, are selectively grazed by livestock. If repeatedly overgrazed, these plants are weakened and gradually decrease in abundance. Less preferred plants, for example, side-oats grama, tall dropseed, Missouri goldenrod, and western ragweed, increase.

If the site is overgrazed for many years, the vegetation often degenerates to predominately Kentucky bluegrass, tall dropseed, annual three-awn, western ragweed, and annual broomweed.

If this site is in excellent condition, the average annual yield of air-dry herbage is 6,000 pounds per acre in years of favorable moisture and 2,500 pounds per acre in years of unfavorable moisture.

LOAMY LOWLAND RANGE SITE

This range site is on bottom land and terraces along rivers and major streams throughout the county. The deep alluvial soils are nearly level and have a loamy surface layer and subsoil. They have moderate to moderately slow permeability and a high available water capacity. They receive extra moisture from the runoff of adjacent sites and from floods or a high water table. Eudora, Kennebec, Judson, and Reading soils are on this site.

The climax plant community is approximately—

	Percent composition by weight
Big bluestem	35
Indiangrass	15
Switchgrass	5
Prairie cordgrass	10
Eastern gamagrass	10
Little bluestem	5
Tall dropseed	3
Maximilian sunflower	5
Carex	2
Woody plants	10

Under prolonged overgrazing, the taller grasses, for example big bluestem, indiangrass, eastern gamagrass, and prairie cordgrass, decrease in amount. Such plants as tall dropseed, purpletop, sedges, and woody plants increase in abundance. Palatable forbs, maximilian sunflower, compassplant, and wholeleaf rosinweed, also decrease when the site is continuously overgrazed. Heath aster, Baldwin ironweed, and tall goldenrod occur in the climax plant community in only minor amounts, but increase when the site is overgrazed. Sites overgrazed for many years may deteriorate until the vegetation is mainly tall dropseed, Kentucky bluegrass, purpletop, buckbrush, and ironweed.

Woody plants are common on the site, especially along stream channels and frequently flooded areas. They increase in abundance with overgrazing. Common woody species are cottonwood, elm, oak, sycamore, and buckbrush.

If this site is in excellent condition, the average annual yields of air-dry herbage is 10,000 pounds per acre in years of favorable moisture and 6,000 pounds per acre in years of unfavorable moisture.

LOAMY UPLAND RANGE SITE

This site is on uplands. The soils are deep to shallow and gently sloping to moderately steep. They have a loamy surface layer and a loamy or a clayey subsoil. They are moderately to slowly permeable. They have low to high available water capacity and provide ample room for root growth. Gymer, Martin, Morrill, Oska, Pawnee, Grundy, Vinland, Shelby and Sibleyville soils are on this range site.

The climax plant community is approximately—

	Percent composition by weight
Big bluestem	30
Little bluestem	20
Indiangrass	15
Switchgrass	10
Side-oats grama	5
Sedges	2
Tall dropseed	5
Compassplant	5
Leadplant	5
Louisiana sagewort	3

Continuous overgrazing causes changes in the climax plant community. The more preferred plants, chiefly big bluestem, indiangrass, little bluestem, and switchgrass, are selectively grazed by livestock. If repeatedly overgrazed, these plants are weakened and gradually decrease in abundance. Among the plants that increase are side-oats grama, tall dropseed, purpletop, Scribner panicum, western ragweed, and Louisiana sagewort.

If the site is overgrazed for many years, the vegetation often degenerates to predominately Kentucky bluegrass, tall dropseed, sedges, goldenrod, Osage orange, and buckbrush.

If this site is in excellent condition, the average annual yield of air-dry herbage is 7,000 pounds per acre in years of favorable moisture and 4,000 pounds per acre in years of unfavorable moisture.

SANDY LOWLAND RANGE SITE

This range site, the Sarpy soil, is on the flood plain along the Kansas River. This soil is deep and nearly level. It has a loamy fine sand surface layer and fine sand substratum. Permeability is very rapid. Available water capacity is low, but some additional moisture is available from the water table.

The climax plant community is approximately—

	Percent composition by weight
Big bluestem	20
Indiangrass	10
Switchgrass	15
Little bluestem	10
Canada wildrye	5
Scribner panicum	5
Purpletop	5
Illinois bundleflower	5
Tall goldenrod	5
Louisiana sagewort	5
Woody plants	20

Under prolonged overgrazing, the taller grasses, chiefly big bluestem, indiangrass, switchgrass, and little bluestem, decrease in amount. Such plants as purpletop, sand paspalum, purple lovegrass, blue grama, and sand dropseed increase in abundance. Louisiana sagewort, western ragweed, and goldenrod occur in the climax plant community in only minor amounts, but increase when the site is overgrazed. Woody plants, chiefly willow, elm, and cottonwood, eventually dominate the vegetation if the site is mismanaged for many years.

If this site is in excellent condition, the average annual yield of air-dry herbage is 7,000 pounds per acre in years of favorable moisture and 5,000 pounds per acre in years of unfavorable moisture.

SAVANNAH RANGE SITE

This site, the Konawa soil, is on uplands. This soil is sloping, deep, and well drained. Typically it has a fine sandy loam surface layer and sandy clay loam subsoil. Permeability is moderate and available water capacity is moderate to high.

The climax plant community is approximately—

	Percent composition by weight
Big bluestem	25
Little bluestem	25
Indiangrass	10
Switchgrass	5
Purpletop	5
Sedges	2
Wildrye	3
Rosette panicum	2
Tickclovers	3
Woody plants	20

The climax vegetation is savannah, consisting of an open or scattered stand of blackjack oak, red oak, and hickory, and an understory of tall grasses and forbs. Under prolonged overgrazing, the taller grasses, chiefly

big bluestem, little bluestem, switchgrass, and indiangrass, decrease in amount. Such plants as purpletop, sedges, rosette panicum, and woody species increase in abundance.

Continuous overgrazing for many years may result in a plant community of dense stands of woody plants and a sparse understory of Kentucky bluegrass, sedges, broomsedge bluestem, and purpletop.

If this site is in excellent condition, the average annual yield of air-dry herbage is 5,500 pounds per acre in years of favorable moisture and 3,500 pounds per acre in years of unfavorable moisture.

SHALLOW LIMY RANGE SITE

This site, the Sogn soil, is on uplands. This soil is sloping to moderately steep and somewhat excessively drained. The loamy surface layer is only 4 to 20 inches thick over limestone. Plant roots are limited in most places.

The climax plant community is approximately—

	Percent composition by weight
Side-oats grama	25
Little bluestem	25
Plains muhly	10
Big bluestem	10
Switchgrass	5
Tall dropseed	5
Fall witchgrass	5
Jersey-tea	5
Prairie-clover	5
Woody plants	5

Under continuous overgrazing, the more preferred plants, such as side-oats grama, big bluestem, little bluestem, plains muhly, switchgrass, and Jersey-tea, are selectively grazed by livestock. If repeatedly overgrazed, these plants are weakened and gradually decrease in abundance. Less preferred plants, for example, tall dropseed, and western ragweed, increase in amount.

It the site is overgrazed for many years, the vegetation often degenerates to predominantly Kentucky bluegrass, annual bromegrass, silver bluestem, western ragweed, and annual broomweed.

If this site is in excellent condition, the average annual yield of air-dry herbage is 4,000 pounds per acre in years of favorable moisture and 2,000 pounds per acre in years of unfavorable moisture.

Woodland

About 40,700 acres is wooded in Jefferson County (*21*). This acreage represents about 11 percent of the total land area. About 95 percent of the woodland is grazed.

Approximately 80 percent of the woodland is on uplands, mostly in the southern part of the county. The rest is scattered in areas on bottom land along streams.

The upland woodland is an oak-hickory association and an understory of grasses (*16*), which is commonly referred to as savannah. Hickory, oak, elm, ash, osage orange, sumac, and buckbrush are the dominant woody plants. Little and big bluestem are the dominant grasses. The rest of the grass yield is produced by indiangrass, sedges, switchgrass, Virginia wildrye, rosette panicum, and a variety of lesser species. The total herbage yield, by types of vegetation, ranges according to the percentage of tree canopy cover. If the canopy cover is 0 to 25 percent, trees produce 10 to 25 percent of the total herbage yield. If the canopy cover is 76 to 100 percent, they produce 90 to 100 percent of the total herbage yield.

The bottom land woodland is a lowland plains hardwood association (*16*), chiefly ash, cottonwood, elm, willow, sycamore, bur oak, soft maple, black walnut, hackberry, hickory, boxelder and smaller woody plants. Stands of cottonwood and willow are dominant in the Kansas River Valley. Elm, ash, and cottonwood are dominant in the Delaware River Valley. Along the tributaries of these rivers, stands are dominantly elm, ash, black walnut, and hackberry.

Woodland management and productivity[6]

Table 3 contains information useful to woodland owners or forest managers planning use of soils for wood crops. Mapping unit symbols for those soils suitable for wood crops are listed alphabetically by soil name, and the ordination symbol for each soil is given. All soils having the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the symbol, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates no significant limitations or restrictions. If a soil has more than one limitation, priority in designating the limitation class is in the order mentioned—x, w, t, d, c, s, f, and r.

In table 3 the soils are also rated for a number of factors to be considered in management. The ratings of slight, moderate, and severe indicate the degree of the major soil limitations.

Ratings of the hazard of erosion indicate the risk of loss of soil in well-managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if some measures are needed to control erosion during logging and road construction; and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of equipment limitation reflect soil characteristics and conditions that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or equipment; *severe* indicates a sea-

[6] RICHARD W. FENWICK, soil scientist, Soil Conservation Service, helped prepare this section.

TABLE 3.—*Woodland management and productivity*

[Only the soils suitable for production of commercial trees are listed in this table. Absence of an entry in a column means the information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Important trees	Potential productivity: Site index	Trees to plant
Eudora: [1] Ec	2o	Slight	Slight	Slight	Slight	Eastern cottonwood American sycamore Hackberry Black walnut Green ash	105 105 -------- -------- --------	Eastern cottonwood, American sycamore, black walnut.
Judson: Ju	2o	Slight	Slight	Slight	Slight	Black walnut White oak Northern red oak	73 -------- --------	Black walnut, eastern cottonwood, green ash.
Kennebec: Kb, [1] Kc	2o	Slight	Slight	Slight	Slight	Black walnut Bur oak Hackberry Green ash Eastern cottonwood	79 63 -------- -------- --------	Black walnut, bur oak, hackberry, green ash, eastern cottonwood, American sycamore.
Kimo: Km	3o	Slight	Moderate	Moderate	Slight	Eastern cottonwood White oak Northern red oak Hackberry Green ash	90 62 -------- -------- --------	Eastern cottonwood, green ash, American sycamore.
[1] Ko: Kimo part	3o	Slight	Moderate	Moderate	Slight	Eastern cottonwood White oak Northern red oak Hackberry Green ash	90 62 -------- -------- --------	Eastern cottonwood, green ash, American sycamore, pecan.
Eudora part	2o	Slight	Slight	Slight	Slight	Eastern cottonwood American sycamore Hackberry Black walnut Green ash	105 105 -------- -------- --------	Eastern cottonwood, American sycamore, black walnut.
Konawa: [1] Kv	3o	Slight	Slight	Slight	Slight	Black walnut Black oak Hackberry Green ash	68 71 -------- --------	Black walnut, hackberry, green ash.
Reading: Re	2o	Slight	Slight	Slight	Slight	Black walnut Hackberry Bur oak Shagbark hickory Southern red oak	73 69 60 62 --------	Black walnut, green ash, hackberry, American sycamore, eastern cottonwood.
Sarpy: [1] Sb: Sarpy part	5s	Slight	Slight	Severe	Slight	Eastern cottonwood	60	Eastern cottonwood, black willow.
Eudora part	2o	Slight	Slight	Slight	Slight	Eastern cottonwood American sycamore Hackberry Black walnut Green ash	105 105 -------- -------- --------	Eastern cottonwood, American sycamore, black walnut.
Wabash: Wc	4w	Slight	Moderate	Moderate	Moderate	Pin oak	75	Pin oak, green ash, eastern cottonwood.
Wh	4w	Slight	Moderate	Severe	Moderate	Pin oak	75	Pin oak, green ash, eastern cottonwood.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

sonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Ratings for seedling mortality indicate the degree to which the soil affects expected mortality of planted tree seedlings when plant competition is not a limiting factor. The ratings are for seedlings from good planting stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 percent; *moderate,* 25 to 50 percent; and *severe,* more than 50 percent.

Considered in the ratings of windthrow hazard are characteristics of the soil that affect the development of tree roots and the ability of soil to hold trees firmly. A rating of *slight* indicates that trees in wooded areas are not expected to be blown down by commonly occurring winds; *moderate,* that some trees are blown down during periods of excessive soil wetness and strong winds; and *severe,* that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

The potential productivity of merchantable trees on a soil is expressed as site index. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Site indexes are based on recognized site index curves for upland oaks (*14*) and cottonwood (*6*).

Trees to plant are those that are suitable for commercial wood production and suitable for the soils (*20*).

Wildlife[7]

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the development of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, inadequate, or inaccessible, wildlife will be scarce or will not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by properly managing the existing plant cover, and by fostering the natural establishment of desirable plants.

In table 4 the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in—

1. Planning the use of parks, wildlife refuges, nature study areas, and other developments for wildlife.
2. Selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat.

[7] LOYD G. WILSON, biologist, Soil Conservation Service, helped prepare this section.

TABLE 4.—*Wildlife habitat potentials*

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates the soil was not rated]

Soil name and map symbol	Potential for habitat elements								Potential as habitat for—			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Eudora:												
[1] Ec	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	--------
Grundy:												
Gb, Gc	Fair	Good	Fair	Good	Good	Good	Fair	Poor	Fair	Good	Poor	Fair.
Gymer:												
Gy	Fair	Good	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.	Fair.
Haig:												
Hc	Good	Fair	Fair	Fair	Poor	--------	Good	Good	Fair	Fair	Good	--------
Judson:												
Ju	Good	Good	Good	Good	Good	--------	Poor	Poor	Good	Good	Poor	--------
Kennebec:												
Kb	Good	Good	Good	Good	Good	--------	Poor	Poor	Good	Good	Poor	--------
[1] Kc	Poor	Poor	Good	Good	Good	--------	Poor	Poor	Poor	Good	Poor	--------
Kimo:												
Km	Good	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good	--------
[1] Ko:												
Kimo part	Good	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good	--------
Eudora part	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	--------

See footnote at end of table.

TABLE 4.—*Wildlife habitat potentials*—Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for—			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Konawa:												
[1] Kv	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Martin:												
Mb, Mc, [1] Mh	Fair	Good	Good	--------	Good	Good	Poor	Very poor.	Good	--------	Very poor.	Good.
[1] Mo:												
Martin part	Fair	Good	Good	--------	Good	Good	Poor	Very poor.	Good	--------	Very poor.	Good.
Oska part	Fair	Good	Good	Fair	Fair	Good	Poor	Very poor.	Good	--------	Very poor.	Good.
Morrill:												
Mv	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	--------	Very poor.	Good.
Oska:												
Oc	Fair	Good	Good	Fair	Fair	Good	Poor	Very poor.	Good	--------	Very poor.	Good.
Pawnee:												
Pb, Pc, [1] Ph	Fair	Fair	Fair	--------	Fair	Fair	Poor	Very poor.	Fair	--------	Very poor.	Fair.
Reading:												
Re	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	--------
Sarpy:												
[1] Sb:												
Sarpy part	Poor	Poor	Fair	Fair	Poor	--------	Very poor.	Very poor.	Fair	Poor	Very poor.	--------
Eudora part	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	--------
Shelby:												
[1] Sc:												
Shelby part	Good	Good	Fair	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Pawnee part	Fair	Fair	Fair	--------	Fair	Fair	Poor	Very poor.	Fair	--------	Very poor.	Fair.
[1] So:												
Shelby part	Fair	Good	Fair	Good	Good	Good	Very poor	Very poor.	Fair	Good	Very poor.	Good.
Pawnee part	Fair	Fair	Fair	--------	Fair	Fair	Very poor.	Very poor.	Fair	--------	Very poor.	Fair.
Sibleyville:												
[1] Ss	Fair	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.	Good.
[1] Sv	Fair	Good	Good	Good	Good	Fair	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Sogn:												
[1] Sw:												
Sogn part	Very poor.	Very poor.	Poor	--------	--------	Poor	Very poor.	Very poor.	Very poor.	--------	Very poor.	Poor.
Vinland part	Poor	Poor	Fair	Fair	Fair	--------	Very poor.	Very poor.	Poor	Fair	Very poor.	--------
Vinland:												
[1] Vc, [1] Vo, [1] Vx	Poor	Poor	Fair	Fair	Fair	--------	Very poor.	Very poor.	Poor	Fair	Very poor.	--------
Wabash:												
Wc	Poor	Poor	Poor	Poor	Poor	--------	Good	Good	Poor	Poor	Good	--------
Wh	Poor	Poor	Poor	Poor	Poor	--------	Poor	Good	Poor	Poor	Fair	--------

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

3. Determining the intensity of management needed for each element of the habitat.
4. Determining areas that are suitable for acquisition to manage for wildlife.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention are required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and requires intensive effort. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. Examples are corn, sorghum, wheat, oats, barley, and soybeans. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considered.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Examples are fescue, bluegrass, switchgrass, bromegrass, timothy, orchardgrass, clover, alfalfa, trefoil, and crownvetch. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considered.

Wild herbaceous plants are native or naturally established herbaceous grasses and forbs, including weeds, that provide food and cover for wildlife. Examples are bluestem, indiangrass, switchgrass, goldenrod, beggarweed, pokeweed, partridgepea, wheatgrass, and grama. Major soil properties that affect the growth of these plants are thickness of the soil, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considered.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. The plants generally regenerate naturally, but can be planted. Examples of native plants are oak, sycamore, cottonwood, cherry, sweetgum, apple, hawthorn, dogwood, persimmon, hickory, black walnut, blackberry, grape, blackhaw, viburnum, gooseberry, and briers. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated good are Russian-olive, autumn-olive, and crabapple. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness.

Coniferous plants are cone-bearing trees, shrubs, or ground cover that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. They are commonly established through natural processes but can be planted or transplated. Examples are pine, spruce, redcedar, and juniper. Major soil properties that affect the growth of coniferous plants are depth of the root zone, available water capacity, and wetness.

Shrubs are bushy woody plants that produce fruits, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Examples are buckbrush, sumac, and sassafras. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Examples of wetland plants are smartweed, wild millet, rushes, sedges, reeds, arrowhead, saltgrass, cordgrass, and cattail. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness.

Shallow water areas are bodies of surface water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control devices in marshes or streams. Examples are muskrat marshes, waterfowl feeding areas, wildlife watering developments, beaver ponds, and other wildlife ponds. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat is cropland, pasture, meadow, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, meadowlark, field sparrow, killdeer, cottontail rabbit, red fox, and woodchuck.

Woodland habitat is a wooded area of hardwoods or conifers or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Examples of wildlife attracted to this habitat are wild turkey, hawks, owls, thrushes, vireos, woodpeckers, tree squirrels, gray fox, raccoon, deer, opossum and badger.

Wetland habitat is an open, marshy, or swampy shallow water area and water-tolerant plants. Examples of wildlife attracted to this habitat are ducks, geese, herons, shorebirds, rails, kingfishers, muskrat, mink, and beaver.

Rangeland habitat provides wild herbaceous plants and shrubs. Examples of wildlife attracted to this

habitat are deer, coyote, prairie chicken, meadowlark, and lark bunting.

The most important game birds are the bobwhite quail and the mourning dove. Both species are abundant in Jefferson County, and both depend largely on woody and herbaceous habitat. Prairie chickens are scarce and are seldom seen. Pheasants are hunted in the northern part of the county, but their numbers are relatively low.

White-tailed deer is the only big game animal in this area in moderate populations that are increasing. Habitat is available along the Kansas and Delaware Rivers and along nearly all of the larger tributaries.

Cottontail rabbits are in all parts of the county. The most productive areas are near streams where food and suitable cover are abundant. Dense brushy areas support the highest rabbit population.

Fox and gray squirrel populations are moderate in Jefferson County. The highest population is in heavily timbered areas near alluvial soils along the major drainageways.

The main species of game fish are bass, bluegill, and channel catfish. These species are available from State fish hatcheries for stocking ponds. Other species, for example, bullhead, carp, crappie, and flathead catfish, are also plentiful.

Habitat development requires the proper location of various types of plant cover. The Soil Conservation Service can provide technical assistance in planning wildlife developments and determining suitable plantings. Additional information and assistance can be obtained from the U.S. Fish and Wildlife Service; the Kansas Forestry, Fish and Game Commission; and the Extension Service.

Recreation

Jefferson County is easily accessible by automobile for large numbers of people seeking recreation. Perry Reservoir is ideally located for attracting visitors from surrounding population centers of Kansas City, St. Joseph, Lawrence, Leavenworth, and Topeka. It is also important to the economy of the county.

The soils of the survey area are rated in table 5 according to limitations that affect their suitability for camp areas, picnic areas, playgrounds, and paths and trails. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreational use by the duration and the season of flooding. Onsite assessment of height, duration, and frequency of flooding is essential in planning recreational facilities.

In table 5 the limitations of soils are rated as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of those measures.

The information in table 5 can be supplemented with additional information in other parts of this survey. Especially helpful is the information on septic tank absorption fields in table 7 and the information on dwellings without basements and local roads and streets in table 6.

Camp areas require such site preparation as shaping and leveling tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

TABLE 5.—*Recreational development*

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Eudora: [1] Ec	Severe: floods	Moderate: floods	Moderate: floods	Slight.
Grundy: Gb, Gc	Moderate: percs slowly, wetness.	Moderate: wetness	Moderate: percs slowly, wetness.	Moderate: wetness.
Gymer: Gy	Moderate: percs slowly	Slight	Moderate: percs slowly, slope.	Slight.
Haig: Hc	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.

See footnote at end of table.

TABLE 5.—*Recreational development*—Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Judson:				
Ju	Slight	Slight	Slight	Slight.
Kennebec:				
Kb, [1] Kc	Severe: floods	Moderate: floods	Severe: floods	Moderate: floods.
Kimo:				
Km	Severe: wetness	Moderate: wetness	Severe: wetness	Moderate: wetness.
[1] Ko:				
Kimo part	Severe: wetness	Moderate: wetness	Severe: wetness	Moderate: wetness.
Eudora part	Severe: floods	Moderate: floods	Moderate: floods	Slight.
Konawa:				
[1] Kv	Slight	Slight	Severe: slope	Slight.
Martin:				
Mb, Mc, [1] Mh	Moderate: too clayey, percs slowly.	Moderate: too clayey	Moderate: too clayey, percs slowly.	Moderate: too clayey.
[1] Mo:				
Martin part	Moderate: too clayey, percs slowly.	Moderate: too clayey	Moderate: too clayey, percs slowly.	Moderate: too clayey.
Oska part	Moderate: percs slowly, too clayey.	Moderate: too clayey	Moderate: percs slowly, too clayey, depth to rock.	Moderate: too clayey.
Morrill:				
Mv	Moderate: percs slowly	Slight	Moderate: percs slowly	Slight.
Oska:				
Oc	Moderate: percs slowly, too clayey.	Moderate: too clayey	Moderate: percs slowly, too clayey, depth to rock.	Moderate: too clayey.
Pawnee:				
Pb, Pc, [1] Ph	Moderate: percs slowly	Moderate: too clayey	Moderate: percs slowly	Moderate: too clayey.
Reading:				
Re	Slight	Slight	Slight	Slight.
Sarpy:				
[1] Sb:				
Sarpy part	Severe: floods, too sandy, soil blowing.	Severe: too sandy, soil blowing.	Severe: floods, too sandy, soil blowing.	Moderate: floods, too sandy, soil blowing.
Eudora part	Severe: floods	Moderate: floods	Moderate: floods	Slight.
Shelby:				
[1] Sc:				
Shelby part	Moderate: percs slowly	Slight	Moderate: percs slowly	Slight.
Pawnee part	Moderate: percs slowly	Moderate: too clayey	Moderate: percs slowly	Moderate: too clayey.
[1] So:				
Shelby part.				
Pawnee part	Moderate: percs slowly	Moderate: slope	Severe: slope	Moderate: too clayey.
Sibleyville:				
[1] Ss	Slight	Slight	Moderate: depth to rock, slope.	Slight.
[1] Sv	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Sogn:				
[1] Sw:				
Sogn part	Moderate: too clayey	Moderate: too clayey	Severe: depth to rock	Moderate: too clayey.
Vinland part	Moderate: too clayey	Moderate: too clayey	Severe: depth to rock	Moderate: too clayey.
Vinland:				
[1] Vc, [1] Vo, [1] Vx	Moderate: too clayey	Moderate: too clayey	Severe: depth to rock	Moderate: too clayey.
Wabash:				
Wc, Wh	Severe: floods, wetness, percs slowly.	Severe: wetness, floods, too clayey.	Severe: wetness, floods, percs slowly.	Severe: wetness, too clayey.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over rock should be sufficient to allow necessary grading.

The design and layout of paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are those that are not wet, are firm after rains, and not dusty when dry, and are not subject to flooding more than once during the period of use. They should have moderate slopes and few or no stones or boulders on the surface.

Engineering[8]

This section provides information about the use of soils for building sites, sanitary facilities, construction materials, and water management. Among those who can benefit from this section are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers (*5*).

The ratings in tables in this section are based on test data and estimated data in the "Soil Properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by the soil survey and used in determining the ratings in this section are grain-size distribution, liquid limit, plasticity index, soil reaction, depth to and hardness of bedrock within 5 or 6 feet of the surface, soil wetness characteristics, depth to a seasonal water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

Based on the information assembled about soil properties, ranges of values may be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values may be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational areas; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternate routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternate sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful in land-use planning and in choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations and testing.

The information is presented mainly in tables. Table 6 shows, for each kind of soil, ratings of the degree and kind of limitations for building site development; table 7, for sanitary facilities; and table 9, for water management. Table 8 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some terms used in this soil survey have different meanings in soil science and in engineering. The Glossary defines many of these terms.

Building Site Development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 6. A *slight* limitation indicates that soil properties are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or inten-

[8] CLIFTON E. DEAL, civil engineer, Soil Conservation Service, helped prepare this section.

TABLE 6.—*Building site development*

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Eudora:					
[1] Ec	Moderate: floods	Severe: floods	Severe: floods	Severe: floods	Severe: frost action.
Grundy:					
Gb, Gc	Severe: wetness	Severe: shrink-swell, low strength.	Severe: shrink-swell, wetness, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Gymer:					
Gy	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
Haig:					
Hc	Severe: wetness, too clayey.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: shrink-swell, wetness, low strength.
Judson:					
Ju	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: frost action.
Kennebec:					
Kb, [1] Kc	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods, frost action, low strength.
Kimo:					
Km	Severe: wetness	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: shrink-swell, low strength.
[1] Ko:					
Kimo part	Severe: wetness	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: shrink-swell, low strength.
Eudora part	Moderate: floods	Severe: floods	Severe: floods	Severe: floods	Severe: frost action.
Konawa:					
[1] Kv	Slight	Slight	Slight	Moderate: slope	Moderate: low strength.
Martin:					
Mb, Mc, [1] Mh	Severe: too clayey	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
[1] Mo:					
Martin part	Severe: too clayey	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Oska part	Severe: depth to rock.	Severe: shrink-swell.	Severe: shrink-swell, depth to rock.	Severe: shrink-swell.	Severe: shrink-swell.
Morrill:					
Mv	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell.
Oska:					
Oc	Severe: depth to rock.	Severe: shrink-swell.	Severe: shrink-swell, depth to rock.	Severe: shrink-swell.	Severe: shrink-swell.
Pawnee:					
Pb, Pc, [1] Ph	Severe: too clayey	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.
Reading:					
Re	Moderate: floods	Severe: floods	Severe: floods	Severe: floods	Severe: low strength, frost action.

See footnote at end of table.

TABLE 6.—*Building site development—Continued*

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Sarpy:					
[1] Sb:					
Sarpy part	Severe: floods, cutbanks cave.	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
Eudora part	Moderate: floods	Severe: floods	Severe: floods	Severe: floods	Severe: frost action.
Shelby:					
[1] Sc:					
Shelby part	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: low strength.
Pawnee part	Severe: too clayey	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.
[1] So:					
Shelby part	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: slope	Moderate: low strength.
Pawnee part	Severe: too clayey	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.
Sibleyville:					
[1] Ss	Moderate: depth to rock.	Moderate: depth to rock, low strength.	Moderate: depth to rock, low strength.	Moderate: depth to rock, low strength.	Moderate: low strength.
[1] Sv	Moderate: depth to rock.	Moderate: depth to rock, low strength.	Moderate: depth to rock, low strength.	Severe: slope	Moderate: low strength.
Sogn:					
[1] Sw					
Sogn part	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Vinland part	Moderate: depth to rock.	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Severe: slope	Moderate: depth to rock.
Vinland:					
[1] Vc	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock, slope.	Moderate: depth to rock.
[1] Vo	Moderate: depth to rock.	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Severe: slope	Moderate: depth to rock.
[1] Vx	Severe: depth to rock, slope.	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Wabash:					
Wc, Wh	Severe: wetness, floods, too clayey.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

sive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are used for pipelines, sewerlines, and telephone and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by the soil wetness of a high seasonal water table, the texture and consistence of soils; the tendency of soils to cave in or slough, and the presence of very firm dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is defined, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and small commercial buildings referred to in table 6 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence from settling or shear failure of the foundation do not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and the large stones in or on the soil are also important considerations in the choice of sites for these structures and

TABLE 7.—*Sanitary facilities*

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Eudora:					
[1] Ec	Moderate: floods	Moderate: seepage, floods.	Moderate: floods	Moderate: floods	Good.
Grundy:					
Gb	Severe: percs slowly, wetness.	Slight	Moderate: too clayey, wetness.	Moderate: wetness	Fair: too clayey.
Gc	Severe: percs slowly, wetness.	Moderate: slope	Moderate: too clayey, wetness.	Moderate: wetness	Fair: too clayey.
Gymer:					
Gy	Severe: percs slowly.	Moderate: slope	Moderate: too clayey.	Slight	Fair: too clayey.
Haig:					
Hc	Severe: percs slowly, wetness.	Moderate: excess humus, wetness.	Severe: wetness, too clayey.	Severe: wetness	Poor: wetness, too clayey.
Judson:					
Ju	Slight	Moderate: seepage	Slight	Slight	Good.
Kennebec:					
Kb, [1] Kc	Severe: floods, wetness.	Severe: floods	Severe: floods, wetness.	Severe: floods, wetness.	Good.
Kimo:					
Km	Severe: percs slowly.	Moderate: floods	Severe: wetness	Severe: wetness	Fair: too clayey.
[1] Ko:					
Kimo part	Severe: percs slowly.	Moderate: floods	Severe: wetness	Severe: wetness	Fair: too clayey.
Eudora part	Moderate: floods	Moderate: floods	Moderate: floods	Moderate: floods	Good.
Konawa:					
[1] Kv	Slight	Severe: seepage	Moderate: seepage	Slight	Good.
Martin:					
Mb, Mc, [1] Mh	Severe: percs slowly.	Moderate: slope	Severe: too clayey.	Slight	Poor: thin layer.
[1] Mo:					
Martin part	Severe: percs slowly.	Moderate: slope	Severe: too clayey.	Slight	Poor: thin layer.
Oska part	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Slight	Poor: too clayey.
Morrill:					
Mv	Severe: percs slowly.	Moderate: slope	Moderate: too clayey.	Slight	Fair: too clayey.
Oska:					
Oc	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Slight	Poor: too clayey.
Pawnee:					
Pb, Pc, [1] Ph	Severe: percs slowly.	Moderate: slope	Severe: too clayey.	Slight	Poor: too clayey.
Reading:					
Re	Moderate: percs slowly.	Moderate: seepage	Moderate: floods, too clayey.	Moderate: floods	Fair: too clayey.
Sarpy:					
[1] Sb:					
Sarpy part	Severe: floods	Severe: floods, seepage.	Severe: floods, seepage.	Severe: floods, seepage.	Poor: too sandy, seepage.
Eudora part	Moderate: floods	Moderate: floods	Moderate: floods	Moderate: floods	Good.
Shelby:					
[1] Sc:					
Shelby part	Severe: percs slowly.	Moderate: slope	Moderate: too clayey.	Slight	Fair: too clayey.

See footnote at end of table.

TABLE 7.—*Sanitary facilities*—*Continued*

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Pawnee part	Severe: percs slowly.	Moderate: slope	Severe: too clayey.	Slight	Severe: too clayey.
[1] So:					
Shelby part	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Moderate: slope	Fair: slope.
Pawnee part	Severe: percs slowly.	Severe: slope	Severe: too clayey.	Moderate: slope	Poor: too clayey.
Sibleyville:					
[1] Ss	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Slight	Fair: thin layer.
[1] Sv	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Moderate: slope	Fair: thin layer.
Sogn:					
[1] Sw:					
Sogn part	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Moderate: slope	Poor: thin layer, area reclaim.
Vinland part	Severe: depth to to rock.	Severe: depth to to rock.	Moderate: depth to rock.	Moderate: slope	Poor: thin layer.
Vinland:					
[1] Vc	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Slight	Poor: thin layer.
[1] Vo	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Moderate: slope	Poor: thin layer.
[1] Vx	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Moderate: depth to rock.	Severe: slope	Poor: thin layer, slope.
Wabash:					
Wc, Wh	Severe: percs slowly, floods, wetness.	Severe: floods	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: wetness, too clayey.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

TABLE 8.—*Construction materials*

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," and "unsuited." Absence of an entry means soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Eudora:				
[1] Ec	Poor: frost action, low strength.	Unsuited: excess fines	Unsuited: excess fines	Good.
Grundy:				
Gb, Gc	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: thin layer.
Gymer:				
Gy	Poor: low strength	Unsuited	Unsuited	Fair: too clayey.
Haig:				
Hc	Poor: shrink-swell, wetness, low strength.	Unsuited	Unsuited	Poor: wetness.
Judson:				
Ju	Poor: frost action, low strength.	Unsuited	Unsuited	Good.
Kennebec:				
Kb, [1] Kc	Poor: excess humus, frost action, low strength.	Unsuited	Unsuited	Good.

See footnote at end of table.

TABLE 8.—*Construction materials—Continued*

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Kimo:				
Km	Poor: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines	Fair: too clayey.
[1] Ko:				
Kimo part	Poor: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines	Fair: too clayey.
Eudora part	Poor: frost action, low strength.	Unsuited: excess fines	Unsuited: excess fines	Good.
Konowa:				
[1] Kv	Good	Unsuited	Unsuited: excess fines	Fair: thin layer.
Martin:				
Mb, Mc, [1] Mh	Poor: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines	Fair: too clayey.
Mo:				
Martin part	Poor: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines	Fair: too clayey.
Oska part	Poor: shrink-swell, low strength, thin layer.	Unsuited	Unsuited	Fair: too clayey.
Morrill:				
Mv	Fair: low strength	Unsuited	Unsuited	Fair: thin layer.
Oska:				
Oc	Poor: shrink-swell, low strength, thin layer.	Unsuited	Unsuited	Fair: too clayey.
Pawnee:				
Pb, Pc, [1] Ph	Poor: shrink-swell	Unsuited	Unsuited	Poor: too clayey.
Reading:				
Re	Poor: low strength, frost action.	Unsuited	Unsuited	Fair: too clayey.
Sarpy:				
[1] Sb:				
Sarpy part	Good	Poor: excess fines	Unsuited	Poor: too sandy.
Eudora part	Fair: frost action	Unsuited: excess fines	Unsuited: excess fines	Good.
Shelby:				
[1] Sc:				
Shelby part	Poor: low strength	Unsuited	Unsuited	Fair: thin layer.
Pawnee part	Poor: shrink-swell	Unsuited	Unsuited	Poor: too clayey.
[1] So:				
Shelby part.				
Pawnee part	Poor: shrink-swell	Unsuited	Unsuited	Poor: too clayey.
Sibleyville:				
[1] Ss, [1] Sv	Fair: frost action	Unsuited	Unsuited	Fair: thin layer.
Sogn:				
[1] Sw:				
Sogn part	Poor: thin layer	Unsuited	Unsuited	Poor: area reclaim.
Vinland part	Poor: thin layer	Unsuited	Unsuited	Poor: area reclaim, thin layer.
Vinland:				
[1] Vc, [1] Vo, [1] Vx	Poor: thin layer	Unsuited	Unsuited	Poor: area reclaim, thin layer.
Wabash:				
Wc, Wh	Poor: wetness, shrink-swell, low strength.	Unsuited	Unsuited	Poor: wetness, too clayey.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

were considered in determining the ratings. Susceptibility to flooding is a serious limitation.

Local roads and streets referred to in table 6 have an all-weather surface that can carry light to medium traffic all year. They consist of subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of

TABLE 9.—*Water management*

[Some of the terms that describe restrictive soil features are defined in the Glossary. Absence of an entry means soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Eudora:						
[1] Ec	Seepage	Low strength, piping.	Not needed	Favorable	Not needed	Not needed.
Grundy:						
Gb, Gc	Favorable	Low strength, shrink-swell.	Percs slowly, wetness.	Slow intake, percs slowly.	Percs slowly, wetness.	Percs slowly, wetness.
Gymer:						
Gy	Favorable	Shrink-swell, low strength.	Not needed	Slow intake, erodes easily.	Favorable	Favorable.
Haig:						
Hc	Favorable	Compressible, low strength, shrink-swell.	Percs slowly	Wetness	Percs slowly, wetness.	Percs slowly, wetness.
Judson:						
Ju	Seepage	Compressible, low strength, shrink-swell.	Not needed	Favorable	Not needed	Favorable.
Kennebec:						
Kb, [1] Kc	Seepage	Low strength, compressible, excess humus.	Floods, frost action.	Floods	Not needed	Favorable.
Kimo:						
Km	Favorable	Shrink-swell, low strength.	Wetness, poor outlets.	Wetness, floods, percs slowly.	Not needed	Not needed.
[1] Ko:						
Kimo part	Favorable	Shrink-swell, low strength.	Wetness, poor outlets.	Wetness, floods, percs slowly.	Not needed	Not needed.
Eudora part	Seepage	Low strength, piping.	Not needed	Favorable	Not needed	Not needed.
Konawa:						
[1] Kv	Seepage	Low strength, unstable fill, piping.	Not needed	Erodes easily	Erodes easily	Erodes easily.
Martin:						
Mb, Mc, [1] Mh	Favorable	Shrink-swell, low strength.	Not needed	Slow intake, slope.	Percs slowly	Favorable.
[1] Mo:						
Martin part	Favorable	Shrink-swell, low strength.	Not needed	Slow intake, slope.	Percs slowly	Favorable.
Oska part	Depth to rock	Low strength, thin layer, shrink-swell.	Not needed	Slow intake, erodes easily, droughty.	Depth to rock	Depth to rock, erodes easily.
Morrill:						
Mv	Favorable	Low strength	Not needed	Slope, erodes easily.	Favorable	Favorable.
Oska:						
Oc	Depth to rock	Low strength, thin layer, shrink-swell.	Not needed	Slow intake, erodes easily, droughty.	Depth to rock	Depth to rock, erodes easily.
Pawnee:						
Pb, Pc, [1] Ph	Favorable	Shrink-swell	Not needed	Percs slowly, slow intake, slope.	Percs slowly, erodes easily.	Percs slowly.
Reading:						
Re	Favorable	Shrink-swell, erodes easily.	Not needed	Slow intake	Not needed	Favorable.

See footnote at end of table.

TABLE 9.—*Water management*—*Continued*

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Sarpy:						
[1] Sb:						
Sarpy part	Seepage	Piping, unstable fill, seepage.	Not needed	Droughty, fast intake, soil blowing.	Not needed	Not needed.
Eudora part	Seepage	Low strength, piping.	Not needed	Favorable	Not needed	Not needed.
Shelby:						
[1] Sc:						
Shelby part	Favorable	Low strength, shrink-swell.	Not needed	Erodes easily, slope.	Favorable	Favorable.
Pawnee part	Favorable	Shrink-swell	Not needed	Percs slowly, slow intake.	Percs slowly, erodes easily.	Percs slowly.
[1] So:						
Shelby part	Favorable	Low strength, shrink-swell.	Not needed	Erodes easily, slope.	Slope	Slope, erodes easily.
Pawnee part	Favorable	Shrink-swell	Not needed	Percs slowly, slow intake, slope.	Percs slowly, erodes easily, slope.	Percs slowly, slope.
Sibleyville:						
[1] Ss, [1] Sv	Depth to rock, slope.	Thin layer, erodes easily.	Not needed	Erodes easily, slope, rooting depth.	Depth to rock, erodes easily, slope.	Erodes easily, slope.
Sogn:						
[1] Sw:						
Sogn part	Depth to rock	Thin layer	Not needed	Rooting depth	Depth to rock	Rooting depth.
Vinland part	Depth to rock	Thin layer	Not needed	Rooting depth, slope.	Depth to rock	Rooting depth.
Vinland:						
[1] Vc, [1] Vo, [1] Vx	Depth to rock, slope.	Thin layer	Not needed	Rooting depth, slope.	Depth to rock, slope.	Rooting depth, slope.
Wabash:						
Wc, Wh	Favorable	Shrink-swell, compressible, low strength.	Floods, percs slowly, wetness.	Slow intake, wetness, floods.	Not needed	Percs slowly, wetness.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The AASHTO and Unified classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones, all of which affect stability and ease of excavation, were also considered.

Sanitary Facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that deal with the ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 7 shows the degree and kind of limitations of each soil for these uses and for use of the soil as daily cover for landfills.

If the degree of soil limitation is indicated by the rating *slight*, soils are favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive kinds of maintenance are required.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil (*12*, *22*). Only the soil horizons between depths of 18 to 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect the absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and a shallow depth to bedrock interfere with installation. Excessive slope may cause lateral seepage and surfacing of the effluent in

downslope areas. Also, soil erosion and soil slippage are hazards where absorption fields are installed in sloping soils.

Some soils are underlain by loose sand and gravel or fractured bedrock at a depth less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and as a result ground water supplies in the area may be contaminated. Soils having a hazard of inadequate filtration are indicated by footnotes in table 7.

Percolation tests are performed to determine the absorptive capacity of the soil and its suitability for septic tank absorption fields. These tests should be performed during the season when the water table is highest and the soil is at minimum absorptive capacity.

In many of the soils that have moderate or severe limitations for septic tank absorption fields, it may be possible to install special systems that lower the seasonal water table or to increase the size of the absorption field so that satisfactory performance is achieved.

Sewage lagoons are shallow ponds constructed to hold sewage while bacteria decompose the solid and liquid wastes. Lagoons have a nearly level flow area surrounded by cut slopes or embankments of compacted, nearly impervious soil material. They generally are designed so that depth of the sewage is 2 to 5 feet. Impervious soil at least 4 feet thick for the lagoon floor and sides is required to minimize seepage and contamination of local ground water. Soils that are very high in organic matter and those that have stones and boulders are undesirable. Unless the soil has very slow permeability, contamination of local ground water is a hazard in areas where the seasonal high water table is above the level of the lagoon floor. In soils where the water is seasonally high, seepage of ground water into the lagoon can seriously reduce its capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the location of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soils affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste, either in excavated trenches or on the surface of the soil. The waste is spread compacted in layers and covered with thin layers of soil. Landfill areas are subject to heavy vehicular traffic. Ease of excavation, risk of polluting ground water, and trafficability affect the suitability of a soil for this purpose. The best soils have a loamy or silty texture, have moderate or slow permeability, are deep to bedrock and a seasonal water table, are free of large stones and boulders, and are not subject to flooding. In areas where the seasonal water table is high, water seeps into the trenches and causes problems in excavating and filling the trenches. Also, seepage into the refuse increases the risk of pollution of ground water. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability that might allow noxious liquids to contaminate local ground water.

Unless otherwise stated, the ratings in table 7 apply only to soil properties and features within a depth of about 6 feet. If the trench is deeper, ratings of slight or moderate may not be valid. Site investigation is needed before a site is selected.

In the area type of sanitary landfill, refuse is placed on the surface of the soil in successive layers. The limitations caused by soil texture, depth to bedrock, and stone content do not apply to this type of landfill. Soil wetness, however, may be a limitation because of difficulty in operating equipment.

Daily cover for sanitary landfills should be soil that is easy to excavate and spread over the compacted fill during both wet and dry weather. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

In addition to these features, the soils selected for final cover of landfills should be suitable for growing plants. In comparison with other horizons, the A horizon in most soils has the best workability, the most organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas, such as slope, erodibility, and potential for plant growth.

Construction Materials

The suitability of each soil as a source of road fill, sand, gravel, and topsoil is indicated in table 8 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet, and described as the survey is made.

Roadfill is soil material used in embankments for roads. Because soil survey interpretations are oriented to local roads and streets rather than highways, the ratings given in table 8 are evaluations of the soils as sources of road fill for low embankments, generally less than 6 feet high and less exacting in design than high embankments. The upper part of the road fill is considered as the subgrade, or foundation, for the road. The ratings reflect the ease of excavating and working the material and the expected performance of the material after it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about soil properties that determine such performance is given in the descriptions of soil series.

The ratings apply to the soil profile between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within the profile. The estimated engineering properties in table 10 provide more specific information about the nature of each horizon that can help determine its suitability for road fill.

TABLE 10.—*Engineering properties and classifications*

[The symbol < means less than; > means greater than. Absence of an entry means data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments >3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				*Pct*					*Pct*	
Eudora:											
[1] Ec	0–12	Silt loam	ML, CL	A-4	0	100	100	90–100	60–98	20–35	2–10
	12–65	Silt loam, very fine sandy loam.	ML, SM	A-4	0	100	100	90–100	60–98	10–30	NP–10
Grundy:											
Gb, Gc	0–15	Silty clay loam	CL, ML	A-6, A-7	0	100	100	95–100	90–100	30–50	5–25
	15–55	Silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95–100	95–100	45–70	25–40
	55–88	Silty clay loam, silty clay.	CH, CL	A-7, A-6	0	100	100	95–100	90–100	30–55	15–35
Gymer:											
Gy	0–11	Silt loam	ML, CL	A-4, A-6	0	100	100	90–100	75–100	25–40	5–15
	11–60	Silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	100	90–100	85–98	35–55	15–25
Haig:											
Hc	0–9	Silty clay loam	CL	A-6, A-7	0	100	100	95–100	90–100	35–45	10–20
	9–31	Silty clay	CH	A-7	0	100	100	95–100	90–100	50–65	30–40
	31–77	Silty clay loam	CL, CH	A-7, A-6	0	100	100	95–100	90–100	35–60	20–30
Judson:											
Ju	0–14	Silt loam	CL, ML	A-6, A-7, A-4	0	100	100	100	95–100	25–50	5–25
	14–72	Silty clay loam, silt loam.	CL, ML	A-6, A-7, A-4	0	100	100	100	95–100	25–50	5–25
Kennebec:											
Kb, [1] Kc	0–42	Silt loam	CL, ML	A-6, A-4	0	100	100	95–100	75–100	25–40	8–20
	42–60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	95–100	75–100	25–45	11–25
Kimo:											
Km	0–30	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95–100	85–95	41–65	20–40
	30–60	Silt loam, very fine sandy loam.	ML, CL, SM	A-4	0	100	100	90–100	55–100	10–25	NP–10
[1] Ko:											
Kimo part	0–30	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95–100	90–100	40–55	15–30
	30–60	Silt loam, very fine sandy loam.	ML, CL, SM	A-4	0	100	100	90–100	55–100	10–25	NP–10
Eudora part	0–12	Silt loam	ML, CL	A-4	0	100	100	90–100	60–98	20–35	2–10
	12–65	Silt loam, very fine sandy loam.	ML, SM	A-4	0	100	100	90–100	60–98	10–30	NP–10
Konawa:											
[1] Kv	0–13	Fine sandy loam	SM, ML	A-4, A-2	0	98–100	98–100	75–100	40–60	10–30	2–10
	13–44	Sandy clay loam, clay loam.	SC, CL	A-4, A-6	0	98–100	98–100	85–100	40–80	26–40	8–18
	44–60	Sandy loam, loamy sand.	SC, SM, ML	A-4, A-2	0	98–100	98–100	75–90	10–50	5–30	NP–10
Martin:											
Mb, Mc, [1] Mh	0–12	Silty clay loam	CL	A-6, A-7	0	100	100	95–100	80–99	35–50	15–25
	12–71	Silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95–100	80–98	41–70	25–40
[1] Mo:											
Martin part	0–12	Silty clay loam	CL	A-6, A-7	0	100	100	95–100	80–99	35–50	15–25
	12–71	Silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95–100	80–98	41–70	25–40

See footnote at end of table.

TABLE 10.—*Engineering properties and classifications—Continued*

Soil name and map symbol	Depth	USDA texture	Classification		Fragments >3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				*Pct*					*Pct*	
Oska part	0–11	Silty clay loam	ML, CL	A-6, A-7	0	100	100	96–100	90–100	38–50	12–22
	11–38	Silty clay, silty clay loam.	CH, CL	A-7-6	0	100	100	96–100	95–100	45–60	20–35
	38	Unweathered bedrock.									
Morrill: Mv	0–9	Loam	ML, CL	A-4, A-6	0	95–100	95–100	85–100	50–85	25–40	8–18
	9–29	Clay loam, sandy clay loam.	CL, SC	A-4, A-6, A-7	0	95–100	95–100	90–100	45–85	30–50	11–30
	29–72	Sandy clay loam, clay loam.	CL, SC	A-4, A-6, A-7	0	95–100	95–100	90–100	45–85	25–50	8–30
Oska: Oc	0–11	Silty clay loam	ML, CL	A-6, A-7	0	100	100	96–100	90–100	38–50	12–22
	11–38	Silty clay, silty clay loam.	CH, CL	A-7-6	0	100	100	96–100	95–100	45–60	20–35
	38	Unweathered bedrock.									
Pawnee: Pb, Pc, [1] Ph	0–14	Clay loam	CL, ML	A-4, A-6, A-7	0	95–100	95–100	85–100	60–95	25–45	7–20
	14–44	Clay	CH	A-7	0	95–100	95–100	85–100	70–90	50–70	25–45
	44–60	Clay, clay loam, sandy clay loam.	CH, CL	A-6, A-7	0	95–100	95–100	85–100	70–85	35–65	20–40
Reading: Re	0–14	Silt loam	ML, CL	A-4, A-6	0	100	100	90–100	85–100	25–40	8–20
	14–74	Silty clay loam	CL	A-6, A-7	0	100	100	95–100	90–100	35–50	15–30
Sarpy: [1] Sb: Sarpy part	0–9	Loamy fine sand	SM	A-2	0	100	100	60–80	15–35	-------	NP
	9–48	Loamy fine sand, fine sand.	SM	A-2	0	100	100	60–80	15–35	-------	NP
	48–60	Loam, silt loam, fine sandy loam.	ML, SM	A-4	0	100	100	85–100	55–95	10–30	NP-6
Eudora part	0–12	Silt loam	ML, CL	A-4	0	100	100	90–100	60–98	20–35	2–10
	12–65	Silt loam, very fine sandy loam.	ML, SM	A-4	0	100	100	90–100	60–98	10–30	NP-10
Shelby: [1] Sc: Shelby part	0–12	Loam	CL, ML	A-6, A-4	0	90–100	90–100	85–100	55–70	25–40	7–20
	12–48	Clay loam	CL	A-6, A-7	0	90–100	95–100	85–100	60–85	35–50	15–30
	48–60	Clay loam, sandy clay loam.	CL, SC	A-6, A-4, A-7, A-2	0	90–100	85–100	75–100	24–85	25–40	8–25
Pawnee part	0–14	Clay loam	CL	A-6, A-4, A-7	0	95–100	95–100	85–100	60–95	25–45	7–20
	14–44	Clay	CH	A-7	0	95–100	95–100	85–100	70–90	50–70	25–45
	44–60	Clay, clay loam, sandy clay loam.	CH, CL	A-6, A-7	0	95–100	95–100	85–100	70–85	35–65	20–40
[1] So: Shelby part	0–12	Loam	CL, ML	A-6, A-4	0	90–100	90–100	85–100	55–85	25–40	7–20
	12–48	Clay loam	CL	A-6, A-7	0	90–100	95–100	85–100	60–85	35–50	15–30
	48–60	Clay loam, sandy clay loam.	CL, SC	A-6, A-4, A-7, A-2	0	90–100	85–100	75–100	24–85	25–40	8–25
Pawnee part	0–14	Clay loam	CL	A-6, A-4, A-7	0	95–100	95–100	85–100	60–95	25–45	7–20
	14–44	Clay	CH	A-7	0	95–100	95–100	85–100	70–85	50–70	25–45
	44–60	Clay, clay loam, sandy clay loam.	CH, CL	A-6, A-7	0	95–100	95–100	85–100	70–85	35–65	20–40

See footnote at end of table.

TABLE 10.—*Engineering properties and classifications—Continued*

Soil name and map symbol	Depth	USDA texture	Classification		Fragments >3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				*Pct*					*Pct*	
Sibleyville:											
[1] Ss, [1] Sv	0–10	Loam	ML, CL	A-4, A-6	0	100	95–100	85–100	60–80	20–35	5–15
	10–18	Loam, clay loam	ML, CL, SC	A-4, A-6	0	100	95–100	80–100	40–70	20–40	8–25
	18–29	Channery loam, channery clay loam.	ML, CL, SC	A-4, A-6	0–20	75–95	70–90	60–90	20–60	20–40	5–15
	29	Weathered bedrock.									
Sogn:											
[1] Sw:											
Sogn part	0–13	Silty clay loam	CL	A-6, A-7	0–10	85–100	85–100	85–100	80–95	25–45	11–23
	13	Unweathered bedrock.									
Vinland part	0–16	Silty clay loam	ML, CL	A-6, A-7	0	85–100	85–100	80–100	75–95	35–50	11–25
	16	Weathered bedrock.									
Vinland:											
[1] Vc, [1] Vo, [1] Vx	0–16	Silty clay loam	ML, CL	A-6, A-7	0	85–100	85–100	80–100	75–95	35–50	11–25
	16	Weathered bedrock.									
Wabash:											
Wc	0–19	Silty clay loam	CL, CH	A-6, A-7	0	100	100	100	95–100	20–55	12–35
	19–60	Silty clay, clay	CH	A-7	0	100	100	100	95–100	40–70	20–55
Wh	0–6	Silty clay	CH	A-7	0	100	100	100	95–100	50–65	25–45
	6–60	Silty clay, clay	CH	A-7	0	100	100	100	95–100	52–70	30–55

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

According to the Unified soil classification system, soils rated *good* have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderate potential frost action, steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor,* regardless of the quality of the suitable material.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 8 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered sand and gravel. Fine-grained soils are not suitable sources of sand or gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of materials, reaction, and stratification are given in the soil series descriptions and in table 10.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to sustain the growth of plants. Also considered is the damage that would result to the area from which the topsoil is taken.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones, are low in content of gravel and other coarse fragments, and have gentle slopes. They are low in soluble salts, which can limit plant growth. They are naturally fertile or respond well to fertilization. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have an appreciable content of gravel, stones, or soluble salts.

Soils rated *poor* are steep soils, poorly drained soils, very sandy soils, very firm clayey soils, soils with suitable layers less than 8 inches thick, and soils having a large content of gravel, stones, or soluble salts.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is much preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter. Consequently, careful preservation and use of material from these horizons is desirable.

Water Management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 9, soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for this use have low seepage potential, which is determined by the permeability and depth over fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and is of favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability, texture, structure, depth to claypan or other layers that influence rate of water movement, depth to the water table, slope, stability of ditchbanks, susceptibility to flooding, salinity and alkalinity, and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments, or a combination of channels and ridges, constructed across a slope to intercept runoff and allow the water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity of slope and steepness, depth to bedrock or other unfavorable material, permeability, ease of establishing vegetation, and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff at nonerosive velocities to outlets. Features that affect the use of soils for waterways are slope, permeability, erodibility, and suitability for permanent vegetation.

Soil Properties

Extensive data about soil properties collected during the soil survey are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of samples selected from representative soil profiles in the field.

When soil borings are made during field mapping, the soil scientist can identify several important soil properties. He notes the seasonal soil moisture condition, or the presence of free water and its depth in the profile. For each horizon, he notes the thickness of the soil and its color; the texture, or the amount of clay, silt, sand, and gravel, or other coarse fragments; the structure, or natural pattern of cracks and pores in the undisturbed soil; and the consistence of soil in-place under the existing soil moisture conditions. He records the root depth of existing plants, determines soil pH or reaction, and identifies any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to characterize key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many of the soil series are available from nearby areas.

Based on summaries of available field and laboratory data, and listed in tables in this section, are estimated ranges in engineering properties and classifications and in physical and chemical properties for each major horizon of each soil in the survey area. Also, pertinent soil and water features, engineering test data, and data obtained from laboratory analyses, both physical and chemical, are presented.

Engineering Properties and Classification

Table 10 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area. These estimates are presented as ranges in values most likely to exist in areas where the soil is mapped.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Information is presented for each of these contrasting horizons. Depth to the upper and lower boundaries of each horizon in a typical profile of each soil is indicated. More information about the range in depth and in properties of each horizon is given for each soil series in "Descriptions of Soils."

Texture is described in table 10 in standard terms used by the United States Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter (*13*, *18*). "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms used by USDA are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (USCS) and the system used by the American Association of State Highway and Transportation Officials (AASHTO). In table 10 soils in the survey area are classified according to both systems.

The Unified system classifies soils according to properties that affect their use as construction material (*2*). Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example CL-ML.

The AASHTO system classifies soils according to those properties that affect their use in highway construction and maintenance (*1*). In this system a mineral soil is classified as one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A–1 are coarse grained and low in content of fines. At the other extreme, in group A–7, are fine-grained soils. Highly organic soils are classified as A–8 on the basis of visual inspection.

When laboratory data are available, the A–1, A–2, and A–7 groups are further classified as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or more for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 13. The estimated classification, without group index numbers, is given in table 10. Also in table 10 the percentage, by weight, is of cobbles or the rock fragments more than 3 inches in diameter estimated for each major horizon. These estimates are determined largely by observing volume percentage in the field and then converting it, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four standard sieves is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates of the many borings made during the survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistency of soil. These indexes are used in both the USCS and the AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior.

Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the soil borings made during the survey.

Physical and Chemical Properties

Table 11 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the representative profile of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships between the soil characteristics observed in the field—particularly soil structure, porosity, and gradation of texture—that influence the downward movement of water in the soil. The estimates are for water movement in a vertical direction when the soil is saturated. Not considered in the estimates are lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in the planning and design of drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops and ornamental or other plants to be grown, in evaluating soil amendments for fertility and stabilization, and in evaluating the corrosivity of soils.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others it was estimated on the basis of the kind of clay and on measurements of similar soils. Size of imposed loadings and the magnitude of changes in soil moisture content are also important factors that influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A *high* shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion, as used in table 11, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rating of soils for corrosivity to concrete is based mainly on the sulfate content, soil texture, and acidity. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Installations of steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely within one kind of soil or within one soil horizon.

Soil and Water Features

Features that relate to runoff or infiltration of water, to flooding, to grading and excavation, and to frost action of each soil are indicated in table 12. This information is helpful in planning land uses and engineering projects that are likely to be affected by the amount of runoff from watersheds, by flooding and a seasonal high water table, by the presence of bedrock in the upper 5 or 6 feet of the soil, or by frost action.

Hydrologic groups are used to estimate runoff after rainfall. Soil properties that influence the minimum rate of infiltration into the bare soil after prolonged wetting are depth to a water table, water intake rate

TABLE 11.—*Physical and chemical properties of soils*

[The symbol < means less than; > means greater than. The erosion tolerance factor (T) is for the entire profile. Absence of an entry mean data were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T	Wind erodibility group
	In	*In/hr*	*In/in*	*pH*						
Eudora:										
[1] Ec	0–12	0.6–2.0	0.20–0.24	6.1–7.3	Low	Low	Low	0.32	5	5
	12–65	0.6–2.0	0.17–0.19	6.6–8.4	Low	Low	Low	0.43		
Grundy:										
Gb, Gc	0–15	0.2–0.6	0.22–0.24	5.6–7.3	Moderate	High	Low	0.37	3	6
	15–55	0.06–0.2	0.11–0.13	5.6–7.3	High	High	Low	0.37		
	55–88	0.2–0.6	0.14–0.20	5.6–7.3	High	High	Moderate	0.37		
Gymer:										
Gy	0–11	0.6–2.0	0.22–0.24	5.1–6.5	Low	Low	Moderate	0.32	5–4	6
	11–60	0.2–0.6	0.12–0.20	5.6–6.5	Moderate	Moderate	Low	0.43		
Haig:										
Hc	0–9	0.2–0.6	0.22–0.24	5.6–6.5	Moderate	High	Moderate			6
	9–31	<0.2	0.12–0.14	5.1–6.0	High	High	Moderate			
	31–77	0.2–0.6	0.18–0.20	6.1–7.3	High	High	Moderate			
Judson:										
Ju	0–14	0.6–2.0	0.21–0.23	5.6–7.3	Moderate	Moderate	Low	0.28	5	7
	14–72	0.6–2.0	0.21–0.23	6.1–7.8	Moderate	Moderate	Low	0.43		
Kennebec:										
Kb, [1] Kc	0–42	0.6–2.0	0.22–0.24	5.6–7.3	Moderate	Moderate	Low	0.32	5	6
	42–60	0.6–2.0	0.20–0.22	6.1–7.3	Moderate	Moderate	Low	0.43		
Kimo:										
Km	0–30	0.06–0.2	0.13–0.20	6.6–8.4	High	High	Low	0.37	5	7
	30–60	0.6–6.0	0.17–0.22	7.4–8.4	Low	Low	Low	0.43		
[1] Ko:										
Kimo part	0–30	0.06–0.2	0.13–0.20	6.6–8.4	High	High	Low			7
	30–60	0.6–6.0	0.17–0.22	7.4–8.4	Low	Low	Low			
Eudora part	0–12	0.6–2.0	0.20–0.24	6.1–7.3	Low	Low	Low	0.32	5	5
	12–65	0.6–2.0	0.17–0.19	6.6–8.4	Low	Low	Low	0.43		
Konawa:										
[1] Kv	0–13	2.0–6.0	0.13–0.18	5.6–6.5	Low	Low	Moderate	0.24	5	2
	13–44	0.2–2.0	0.15–0.19	5.1–6.0	Low	Moderate	Moderate	0.32		
	44–60	2.0–6.0	0.08–0.15	5.1–6.5	Low	Low	Moderate	0.24		
Martin:										
Mb, Mc, [1] Mh	0–12	0.2–0.6	0.21–0.23	5.6–6.5	Moderate	High	Low	0.37	3–2	7
	12–71	0.06–0.2	0.12–0.18	5.6–7.8	High	High	Low	0.37		
[1] Mo:										
Martin part	0–12	0.2–0.6	0.21–0.23	5.6–6.5	Moderate	High	Low	0.37	3–2	7
	12–71	0.06–0.2	0.12–0.18	5.6–7.8	High	High	Low	0.37		
Oska part	0–11	0.2–0.6	0.21–0.23	5.6–6.5	Moderate	Moderate	Moderate	0.43	3–2	7
	11–38	0.06–0.2	0.12–0.18	5.6–7.8	High	Moderate	Low	0.32		
	38									
Morrill:										
Mv	0–9	0.6–2.0	0.17–0.21	5.6–7.3	Low	Low	Moderate	0.28	5–4	6
	9–29	0.2–0.6	0.15–0.19	5.6–6.5	Moderate	Moderate	Moderate	0.28		
	29–72	0.2–2.0	0.15–0.18	5.6–7.3	Low	Low	Moderate	0.37		
Oska:										
Oc	0–11	0.2–0.6	0.21–0.23	5.6–6.5	Moderate	Moderate	Moderate	0.43	3–2	7
	11–38	0.06–0.2	0.12–0.18	5.6–7.8	High	Moderate	Low	0.32		
	38									
Pawnee:										
Pb, Pc, [1] Ph	0–14	0.2–0.6	0.17–0.22	5.6–6.5	Moderate	Moderate	Low	0.32	3–2	6
	14–60	0.06–0.2	0.09–0.17	5.6–7.3	High	High	Low	0.32		

See footnote at end of table.

TABLE 11.—*Physical and chemical properties of soils—Continued*

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
						Uncoated steel	Concrete	K	T	
	In	*In/hr*	*In/in*	*pH*						
Reading:										
Re	0–14	0.6–2.0	0.21–0.23	5.6–7.3	Low	Low	Low	0.32	5	6
	14–74	0.2–2.0	0.16–0.20	5.6–7.3	Moderate	Moderate	Low	0.43		
Sarpy:										
[1] Sb:										
Sarpy part	0–9	>6.0	0.05–0.09	6.6–8.4	Low	Low	Low	0.15	5	1
	9–48	>6.0	0.05–0.09	7.4–8.4	Low	Low	Low	0.15		
	48–60	0.6–2.0	0.17–0.19	6.6–8.4	Low	Moderate	Low	0.32		
Eudora part	0–12	0.6–2.0	0.20–0.24	6.1–7.3	Low	Low	Low	0.32	5	5
	12–65	0.6–2.0	0.17–0.19	6.6–8.4	Low	Low	Low	0.43		
Shelby:										
[1] Sc:										
Shelby part	0–12	0.6–2.0	0.17–0.21	5.6–7.3	Moderate	Moderate	Moderate	0.28	4	6
	12–48	0.2–0.6	0.16–0.18	5.6–6.5	Moderate	Moderate	Moderate	0.28		
	48–60	0.2–0.6	0.16–0.18	6.6–8.4	Moderate	Moderate	Moderate	0.37		
Pawnee part	0–14	0.2–0.6	0.17–0.22	5.6–6.5	Moderate	Moderate	Low	0.32	3–2	6
	14–60	0.06–0.2	0.09–0.17	5.6–7.3	High	High	Low	0.32		
[1] So:										
Shelby part	0–12	0.6–2.0	0.17–0.21	5.6–7.3	Moderate	Moderate	Moderate	0.28	4	6
	12–48	0.2–0.6	0.16–0.18	5.6–6.5	Moderate	Moderate	Moderate	0.28		
	48–60	0.2–0.6	0.16–0.18	5.6–8.4	Moderate	Moderate	Moderate	0.37		
Pawnee part	0–14	0.2–0.6	0.17–0.22	5.6–6.5	Moderate	Moderate	Low	0.32	3–2	6
	14–60	0.06–0.2	0.09–0.17	5.6–7.3	High	High	Low	0.32		
Sibleyville:										
[1] Ss, [1] Sv	0–10	0.6–2.0	0.18–0.21	5.6–7.3	Low	Low	Moderate	0.28	3	6
	10–18	0.6–2.0	0.16–0.19	5.1–6.5	Low	Low	Moderate	0.28		
	18–29	0.6–2.0	0.12–0.17	5.1–6.5	Low	Low	Moderate	0.28		
	29	-----	-----	-----	-----	-----	-----	-----		
Sogn:										
[1] Sw:										
Sogn part	0–13	0.6–2.0	0.17–0.22	6.1–8.4	Moderate	Low	Low	0.28	1	4L
	13	-----	-----	-----	-----	-----	-----	-----		
Vinland part	0–16	0.6–2.0	0.18–0.22	5.6–7.8	Moderate	Moderate	Low	0.37	2	6
	16	-----	-----	-----	-----	-----	-----	-----		
Vinland:										
[1] Vc, [1] Vo, [1] Vx	0–16	0.6–2.0	0.18–0.22	5.6–7.8	Moderate	Moderate	Low	0.37	2	6
	16	-----	-----	-----	-----	-----	-----	-----		
Wabash:										
Wc	0–19	0.06–0.2	0.18–0.21	5.6–7.3	High	High	Moderate	-----	-----	4
	19–60	<0.06	0.08–0.12	5.6–7.8	Very high	High	Moderate	-----		
Wh	0–6	<0.06	0.12–0.16	5.6–7.3	Very high	High	Moderate	-----	-----	4
	6–60	<0.06	0.08–0.12	5.6–7.8	Very high	High	Moderate	-----		

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

and permeability after prolonged wetting, and depth to layers of slowly or very slowly permeable soil.

Flooding is rated in general terms that describe the frequency, duration, and period of the year when flooding is most likely. The ratings are based on evidences in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; absence of distinctive soil horizons that form in soils of the area that are not subject to flooding; local information about floodwater heights and the extent of flooding; and local knowledge that relates the unique landscape position of each soil to historic floods. Most soils in low positions on the landscape where flooding is likely to occur are classified as fluvents at the suborder level or as fluventic subgroups. See the section "Classification of the Soils."

The generalized description of flood hazard is of value in land use planning and provides a valid basis for land use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

A *seasonal high water table* is the highest level of a saturated zone more than 6 inches thick in soils for a

TABLE 12.—*Soil and water features*

[Absence of an entry indicates the feature is not a concern. The symbol < means less than; > means greater than]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	
					Ft			*In*		
Eudora:										
[1] Ec	B	Rare			>6.0			>60		High.
Grundy:										
Gb, Gc	C	None			1.0–2.0	Perched	Dec–Mar	>60		Moderate.
Gymer:										
Gy	C	None			>6.0			>60		Moderate.
Haig:										
Hc	C/D	None			0–2.0	Perched	Dec–Apr	>60		High.
Judson:										
Ju	B	None			>6.0			>60		Moderate.
Kennebec:										
Kb, [1] Kc	B	Common	Brief	Mar–Jun	>6.0			>60		High.
Kimo:										
Km	C	Rare			2.0–6.0	Apparent	Mar–Jun	>60		High.
[1] Ko:										
Kimo part	C	Rare			2.0–6.0	Apparent	Mar–Jun	>60		High.
Eudora part	B	Rare			>6.0			>60		High.
Konawa:										
[1] Kv	B	None			>6.0			>60		Low.
Martin:										
Mb, Mc, [1] Mh	C	None			>6.0			>40	Rippable	High.
[1] Mo:										
Martin part	C	None			>6.0			>40	Rippable	High.
Oska part	C	None			>6.0			20–40	Hard	Moderate.
Morrill:										
Mv	B	None			>6.0			>60		Moderate.
Oska:										
Oc	C	None			>6.0			20–40	Hard	Moderate.
Pawnee:										
Pb, Pc, [1] Ph	D	None			>6.0			>60		High.
Reading:										
Re	C	Rare			>6.0			>60		High.
Sarpy:										
[1] Sb:										
Sarpy part	A	Occasional	Brief	Mar–Jun	>6.0			>60		Low.
Eudora part	B	Rare			>6.0			>60		High.
Shelby:										
[1] Sc:										
Shelby part	B	None			>6.0			>60		Moderate.
Pawnee part	D	None			>6.0			>60		High.
[1] So:										
Shelby part	B	None			>6.0			>60		Moderate.
Pawnee part	D	None			>6.0			>60		High.
Sibleyville:										
[1] Ss, [1] Sv	B	None			>6.0			20–40	Rippable	Moderate.
Sogn:										
[1] Sw:										
Sogn part	D	None			>6.0			4–20	Hard	Moderate.
Vinland part	C/D	None			>6.0			10–20	Rippable	Moderate.

See footnote at end of table.

TABLE 12.—*Soil and water features—Continued*

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	
					Ft			*In*		
Vinland: [1] Vc, [1] Vo, [1] Vx	C/D	None			>6.0			10–20	Rippable	Moderate.
Wabash: Wc, Wh	D	Occasional	Brief to long.	Nov–May	0–1.0	Perched	Nov–May	>60		Moderate.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed during the course of the soil survey. Indicated are the depth to the seasonal high water table; the kind of water table, whether perched, artesian, or the upper part of the ground water table; and the months of the year that the high water commonly is present. Only those saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not to construct basements and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth of bedrock is shown for all soils that are underlain by bedrock at depths of 5 to 6 feet or less. For many soils, the limited range in depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and other observations during the soil mapping. The relative hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200 horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action refers to the likelihood of damage of pavements and other structures by frost heaving and low soil strength after thawing. Frost action is defined as freezing temperatures in the soil and movement of soil moisture into the freezing zone, which causes the formation of ice lenses. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly or sandy soils are the least susceptible.

Soil Test Data

Table 13 contains engineering test data for some of the major soils in Jefferson County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction, or moisture-density, data are important to earthwork. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, density decreases with increase in moisture content. The highest dry density obtained in the compactive test is termed *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material as has been explained in table 10.

Formation and Classification of Soils

This part of the survey describes the factors of soil formation and tells how they have affected the soils in Jefferson County. It also explains the system of soil classification currently used and classifies each soil series according to that system.

Factors of Soil Formation

Soil forms through soil-forming processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by: (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed, since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material.

TABLE 13.—*Engineering*

[Tests performed by the State Highway Commission of Kansas in accordance with standard procedures of the American

Soil name and location	Parent material	Report number	Depth	Moisture-density [1]	
				Maximum dry density	Optimum moisture
			In	*Lb/cu ft*	*Pct*
Eudora silt loam:					
NW¼SE¼ sec. 33, T. 11S., R. 19E. 1,150 feet east and 300 feet south of center, 0.7 mile south and 0.7 mile west of Williamstown.	Alluvium.	S70 Kans.			
		44–2–1	0–10	101	18
		44–2–3	20–60	101	18
Grundy silty clay loam:	Peorian loess.	68 Kans.			
Sec. 4, T. 9S., R. 19E. 1,950 feet east and 650 feet north of the SW corner, 5 miles north and 0.4 mile east of Oskaloosa. Modal profile.		44–9–1	0–10	99	21
		44–9–2	10–28	93	22
		44–9–4	26–60	97	23
		44–9–5	60–72	104	17
Sec. 15, T. 8S., R. 19E. 500 feet north and 200 feet west of the southeast corner of the section, 2 miles north of Winchester. Modal profile.	Peorian loess.	68 Kans.			
		44–11–1	0–13	99	20
		44–11–3	17–28	95	23
		44–11–6	44–66	99	21
Kennebec silt loam:	Recent alluvium.	68 Kans.			
Sec. 25, T. 7S., R. 19E. 500 feet east and 100 feet south of center of section, 4.6 miles east of Nortonville. Modal profile.		44–13–1	0–24	111	14
		44–13–3	36–60	109	15
		44–13–4	60–90	110	16
Sec. 31, T. 9S., R. 19E. 300 feet west and 200 feet south of center of section, 1.7 miles northwest of Oskaloosa. Modal profile.	Recent alluvium.	68 Kans.			
		44–14–2	9–36	99	17
		44–14–4	48–80	103	15
Oska silty clay loam:	Residuum from limestone or shale.	68 Kans.			
Sec. 26, T. 10S., R. 18E. 500 feet west and 150 feet south of center of section, 5.5 miles north and 1.0 mile east of Perry. Depth to B2t is less than in a modal profile.		44–6–1	0–7	97	22
		44–6–3	11–22	97	24
Pawnee clay loam:	Kansas till.	68 Kans.			
SE¼SW¼ sec. 26, T. 10S., R. 18E. 1,400 feet east and 900 feet north of the SW corner, 5.2 miles north and 0.8 mile east of Perry. Modal profile.		44–7–1	0–8	110	15
		44–7–3	14–29	103	20
		44–7–5	44–60	109	18
NW¼NE¼ sec. 4, T. 9S., R. 19E. 300 feet south and 2,400 feet west of NE corner, 3 miles southwest of Winchester and 0.6 mile east of U.S. 59. Modal profile.	Kansas till.	68 Kans.			
		44–10–1	0–9	95	23
		44–10–2	9–23	91	25
		44–10–4	30–46	100	23
		44–10–5	46–66	106	19
Reading silt loam:	Alluvium.	S70 Kans.			
NW¼NW¼ sec. 32, T. 11S., R. 19E. 900 feet east and 460 feet south of the northwest corner, 100 feet west of road at pipeline crossing and 0.5 mile south of Williamstown.		44–3–1	0–20	101	19
		44–3–3	28–44	100	18
		44–3–4	44–70	102	19
Shelby clay loam:	Kansas till.	68 Kans.			
NE¼NE¼ sec. 31, T. 9S., R. 19E. 1,100 feet west and 175 feet south of the northeast corner, 2 miles northwest of Oskaloosa. Modal profile.		44–15–1	0–11	107	17
		44–15–3	17–29	106	17
		44–15–6	50–70	117	14
Shelby loam:	Kansas till.	68 Kans.			
SE¼SW¼ sec. 11, T. 8S., R. 19E. 1,450 feet east and 200 feet north of the SW corner, 2.6 miles north and 0.2 mile west of Winchester. Modal profile.		44–12–1	0–12	110	14
		44–12–3	18–32	105	16
		44–12–4	32–48	106	17
		44–12–5	48–60	115	14
SW¼NW¼ sec. 16, T. 10S., R. 20E. 550 feet east and 2,000 feet south of northwest corner, 1.0 mile south and 0.6 mile east of McLouth.	Kansas till.	S70 Kans.			
		44–5–1	0–14	109	16
		44–5–4	23–40	109	17
		44–5–5	40–70	113	14

See footnote at end of table.

test data

Association of State Highway and Transportation Officials (AASHTO) except as stated in footnotes 1 and 2]

Mechanical analysis [2]							Liquid limit	Plasticity index	Classification	
Percentage less than 3 inches passing sieve—			Percentage smaller than—						AASHTO [3]	Unified [4]
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
100	100	98	89	51	18	13	32	7	A-4(8)	CL-ML
100	100	96	75	25	3	2	28	2	A-4(8)	ML
100	100	98	94	74	34	26	35	12	A-6(9)	CL-ML
100	100	98	97	85	59	49	60	34	A-7-6(20)	CH
100	100	98	95	80	47	36	49	26	A-7-6(16)	CL
100	99	94	89	64	34	27	33	15	A-6(10)	CL
100	99	98	94	68	34	27	35	11	A-6(8)	CL-ML
100	99	99	97	87	59	50	60	36	A-7-6(20)	CH
100	99	99	98	80	45	36	48	26	A-7-6(16)	CL
100	99	75	67	47	21	16	27	9	A-4(8)	CL
100	99	76	69	52	25	19	29	12	A-6(9)	CL
100	99	79	72	50	26	21	30	13	A-6(9)	CL
100	100	97	90	66	32	24	36	14	A-6(10)	CL
100	100	93	87	62	27	21	34	12	A-6(9)	CL-ML
100	99	94	90	72	48	39	43	18	A-7-6(12)	CL-ML
100	99	95	92	78	57	49	49	23	A-7-6(15)	CL-ML
100	92	68	60	40	22	16	29	10	A-4(7)	CL
99	95	76	70	58	45	39	50	31	A-7-6(18)	CL or CH
99	92	71	65	50	34	27	38	22	A-6(12)	CL
100	98	91	84	62	36	28	43	16	A-7-6(11)	CL-ML
100	99	85	78	62	47	43	61	36	A-7-6(20)	CH
100	98	90	86	67	45	39	55	34	A-7-6(19)	CH
100	93	75	70	57	40	34	49	30	A-7-6(18)	CL
100	100	98	92	64	32	22	36	13	A-6(9)	CL-ML
100	100	99	96	75	39	30	37	16	A-6(10)	CL
100	100	100	98	79	42	31	39	19	A-6(12)	CL
100	98	77	68	45	28	24	32	12	A-6(9)	CL
100	100	80	71	50	30	26	35	17	A-6(11)	CL
100	98	59	51	33	20	16	25	10	A-4(5)	CL
100	92	63	57	41	23	16	26	9	A-4(6)	CL
100	92	70	65	53	38	32	37	18	A-6(10)	CL
100	93	70	65	53	37	32	41	23	A-7-6(12)	CL
98	83	24	21	18	16	15	26	9	A-2-4(0)	SC
100	92	60	55	42	28	24	28	8	A-4(5)	CL
100	93	70	65	54	38	31	46	26	A-7-6(14)	CL
100	94	73	67	55	36	27	40	23	A-6(13)	CL

TABLE 13.—*Engineering*

Soil name and location	Parent material	Report number	Depth	Moisture-density [1]	
				Maximum dry density	Optimum moisture
			In.	*Lb./cu. ft.*	*Pct.*
Wabash silty clay loam: NE¼SE¼ sec. 29, T. 11S., R. 19E. 2,000 feet north and 400 feet west of the SE corner, 0.7 mile east of Williamstown.	Alluvium.	S70 Kans.			
		44-4-2	9–28	95	23
		44-4-3	28–40	98	22
		44-4-4	40–70	101	20

[1] Based on AASHTO Designation T99-61, Method A, with the following variations: (1) All material is ovendried at 230°F.; (2) all material is crushed in a laboratory crusher after drying; and (3) no time is allowed for dispersion of moisture after mixing with the soil material.

[2] Mechanical analyses according to the AASHTO Designation T88-57 (*1*) with the following variations. (1) All material is ovendried at 230°F. and crushed in a laboratory crusher; (2) the sample is not soaked prior to dispersion; (3) sodium silicate is used as the dispersing agent; and (4) dispersing time, in minutes, is established by dividing the plasticity index value by 2; the maximum time is 15 minutes, and the minimum time is 1 minute. Results by this procedure frequently may differ somewhat from results obtained by the soil survey procedure of

Climate and plant and animal life, chiefly plants, are active factors of the soil formation. They act on the parent material that has accumulated through the weathering of rock and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that forms, and, in extreme cases, determines it almost entirely. Time is always required for differentiation of soil horizons. Usually, a long time is required for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many processes of soil formation are unknown. Soils are in a constant state of change.

Parent material

Parent material is the unconsolidated material from which the soil forms. It is a result of the physical and chemical weathering of large rocks into particles of gravel, sand, silt, and clay. Parent material affects the texture and most other properties of the soil. Soils differ mainly because of the difference in their parent material. The parent materials of the soils of Jefferson County are residuum weathered from limestone, sandstone, and shale of the Upper Pennsylvanian System, and from water, glacial, and wind transported sediments of the Quaternary System (*23*).

Upper Pennsylvanian limestone, sandstone, and shale.—The parent material for many of the soils is derived from the Upper Pennsylvanian System. This bedrock ranges from the Willard Shale, which crops out in the northwestern part of the county, to the Lawrence Formation, which crops out in the southeastern part.

Martin, Sibleyville, Oska, Sogn, and Vinland soils formed in residuum weathered from the bedrock. Martin and Vinland soils formed in material weathered from silty and clayey shale. Sibleyville soils formed in material weathered from sandstone and interbedded loamy shale. Sogn soils formed in material weathered from limestone. Oska soils formed in material weathered from limestone or shale that is closely associated with limestone.

Alluvium.—Old and recent alluvium are sediments transported by water to their present location. The old alluvial sediments, the Illinoian and Kansan stages, occur on high terraces along the Kansas and Delaware Rivers. Gymer soils formed in silty sediments and Haig soils in clayey sediments on these terraces. Recent alluvial sediments occur on low flood plains and high flood plains or low terraces along the Kansas River and its tributaries. On the low flood plains are Sarpy soils, which formed in sandy sediments; Eudora and Kennebec soils, which formed in silty sediments; and Kimo soils, which formed in clayey sediments. On the high flood plains or low terraces are Judson soils, which formed in silty sediments on the Newman Terrace along the Kansas River; Reading soils, which formed in silty sediments; and Wabash soils, which formed in clayey sediments.

Kansas till and glaciofluvial deposits.—Kansas till and glaciofluvial sediments were transported to Jefferson County during the Kansan stage of the Pleistocene Series. The Kansan glacier covered all of the county. Glacial deposits occur in all upland areas. Morrill and Shelby soils formed in loamy till and, in some places, loamy glaciofluvial sediments. Pawnee soils formed in clayey till and glaciofluvial sediments.

Loveland and Peoria Formations.—Eolian loess sediments were deposited during the Illinoian and early Wisconsin stages of the Pleistocene Series. Gymer soils formed in silty sediments of the Loveland Formation. Grundy soils formed in silty and clayey eolian sediments of the Peoria Formation. They occur on crests on landscapes in the northeastern part of the county.

Climate

Climate influences both physical and chemical weathering processes and the biological forces at work in the parent material. The downward movement of

test data—Continued

Mechanical analysis [2]							Liquid limit	Plasticity index	Classification	
Percentage less than 3 inches passing sieve—			Percentage smaller than						AASHTO [3]	Unified [4]
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
100	100	97	94	83	58	45	20	26	A-7-6(16)	CL
100	100	97	95	86	57	47	57	31	A-7-6(19)	CH
100	100	99	94	79	44	35	43	23	A-7-6(14)	CL

the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses data used in this table are not suitable for use in naming textural classes for soils.

[3] Based on AASHTO Designation M 145-49, (Pt. 1, Ed. 8).

[4] Based on ASTM Stand. D 2487-69.

water is a major factor in transforming the parent material into a soil that has distinct horizons. The amount of water that percolates through the soil depends mainly on temperature, type and intensity of precipitation, and humidity and to a lesser extent on relief and nature of the soil material.

Soil-forming processes are most active when the soil is warm and moist. In Jefferson County these processes are most active during the warmer months. Soil structure is modified by freezing and thawing. The alternate wetting and drying, as a result of the sub-humid climate of the county, is an important process in the formation of soil structure.

Climate is an important factor in causing differences in soils over a wide region, but has slight effect on soils in a small area, such as Jefferson County.

Plant and animal life

Soil formation is influenced by plant and animal life. As soil features change, the biological life adjusts accordingly. In a given climatic region, the particular kinds of plant and animal life are determined by the other factors of soil formation.

Plants provide a cover for the soil, supply organic matter, and bring nutrients from lower layers to the surface layer. Trunks, stems, leaves, and roots of plants are decomposed by micro-organisms to form organic matter. Organic matter physically and chemically influences the color, the structure, and other properties of the soil. It creates a more favorable environment for biological activity within the soil.

Most soils in Jefferson County formed under tall prairie grasses. Some, for example, Sogn soils, formed under tall and mid prairie grasses. Soils derived from recent alluvium formed under tall prairie grasses and lowland plains hardwood plants.

Bacteria, fungi, and other organisms influence soil formation by aiding in decomposition of organic materials and weathering of the parent material. This animal life influenced the chemical, physical, and biological processes that strongly affect soil formation. Worms, for example, influence the color and structure of soils.

The use of soil by man has increased erosion, increased or decreased the supply of organic matter, and changed the relief by land leveling. It has thereby changed or offset the normal processes of soil formation.

Relief

Relief influences soil formation through runoff, drainage, and other effects of water, including normal and accelerated erosion. The amount of water that soaks into the soil depends partly on topography. Generally, runoff is greater on steep soils than on gently sloping soils, and more soil material is lost through erosion. Level or depressional topography influences the amount of moisture available because the soil receives extra water as runoff from higher parts. Because of this additional water, the upper layers of the soil profile are gray colored or mottled and thicker. Level or gently sloping soils generally have more strongly defined horizons than steeper soils. Runoff is slow on level soils; thus, the water percolates through the soil or ponds. Most nearly level soils forming in alluvium receive additional sediments during flooding.

Time

Time is required for soil formation. The length of time needed depends largely on the other factors of soil formation. As water moves through the soil profile, soluble matter and fine particles gradually are leached from the surface layer and deposited in the subsoil. The amount of leaching depends on how much time has elapsed and how much water has penetrated the soil. For example, the Eudora soils, which formed in recent alluvium, are young soils that show very little horizon development except for a slight darkening of their surface layer. Martin soils, which have been exposed to soil-forming processes for thousands of years, are older and have well-defined horizons.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to compare their relationship with one another and the whole environment, and to develop principles that help us understand their behavior and response. First through classification and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; and in constructing highways and other engineering structures. Soils are classified in broad classes to facilitate study and comparison of large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in continuing developments should search the latest literature available (*15*).[9]

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. The same soil property, or subdivision of this property, may be used in several different categories. In table 14, the soil series recognized in Jefferson County are classified in three categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

[9] See the unpublished working document "Selected Chapters from the Unedited Text of Soil Taxonomy" available in the SCS State Office, Salina, Kansas.

ORDER. Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. Three exceptions are the Entisols, Histosols, and Vertisols, all of which occur in many different climates. Each order is identified by a word of three or four syllables ending in *sol* (Moll-i-sol).

SUBORDER. Each order is divided into suborders according to those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders are more narrowly defined than are the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of a water table at a shallow depth, soil climate, the accumulation of clay, iron, or organic carbon in the upper solum, cracking of soils caused by a decrease in soil moisture, and fine stratification. Each suborder is identified by a word of two syllables. The last syllable indicates the order. An example is *Aquoll* (*Aqu,* meaning water or wet, and *oll,* from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of uniformity in the kinds and sequence of soil horizons. The horizons are those in which clay, carbonates, and other constituents have accumulated or have been removed and those that have pans that interfere with growth of roots, movement of water, or both. Some features considered are soil acidity, soil climate, soil composition, and soil color. Each great group is identified by a word of three or four syllables; a prefix is added to the name of the suborder. An example is Haplaquoll (*Hapl,* meaning simple horizons, *aqu* for wetness or water, and *oll,* from Mollisols).

SUBGROUP. Each great group is divided into subgroups, one representing the central, or typic, segment of the group, and others called intergrades, which have properties of the group and also one or more properties of another great group, suborder, or order. Other subgroups may have soil properties unlike those of

TABLE 14.—*Classification of the soils*

[An asterisk in the first column indicates a taxadjunct to the series. See text for a description of those characteristics of this taxadjunct that are outside the range of the series]

Soil name	Family or higher taxonomic class
Eudora	Coarse-silty, mixed, mesic Fluventic Hapludolls
Grundy	Fine, montmorillonitic, mesic Aquic Argiudolls
Gymer	Fine, montmorillonitic, mesic Typic Argiudolls
*Haig	Fine, montmorillonitic, mesic Typic Argiaquolls
Judson	Fine-silty, mixed, mesic Cumulic Hapludolls
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
Kimo	Clayey over loamy, montmorillonitic, mesic Aquic Hapludolls
*Konawa	Fine-loamy, mixed, thermic Ultic Haplustalfs
Martin	Fine, montmorillonitic, mesic Aquic Argiudolls
Morrill	Fine-loamy, mixed, mesic Typic Argiudolls
Oska	Fine, montmorillonitic, mesic Typic Argiudolls
*Pawnee	Fine, montmorillonitic, mesic Aquic Argiudolls
Reading	Fine-silty, mixed, mesic Typic Argiudolls
Sarpy	Mixed, mesic Typic Udipsamments
Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Sibleyville	Fine-loamy, mixed, mesic Typic Argiudolls
Sogn	Loamy, mixed, mesic Lithic Haplustolls
Vinland	Loamy, mixed, mesic, shallow Typic Hapludolls
Wabash	Fine, montmorillonitic, mesic Vertic Haplaquolls

any other great group, suborder, or order. Each subgroup is identified by one or more adjectives and the name of the great group. An example is Typic Haplaquolls (a typical Haplaquoll).

FAMILY. Soil families are established within a subgroup primarily on the basis of properties important to the growth of plants or to the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, soil depth, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives denote the texture and mineralogy, for example, that are used as family differentiae. An example is the coarse-loamy, mixed, mesic family of Typic Haplaquolls.

Environmental Factors Affecting Soil Use

On the pages that follow is information on the history and development of Jefferson County; the physiography, relief, and drainage; the climate; the water supply; and the natural vegetation. Also on these pages are facts about industry and natural resources, transportation, community facilities, and land use. The statistics of agriculture and population are from Census of Agriculture and Kansas State Board of Agriculture reports.

History and Development

Jefferson County, originally part of the Delaware and Kaw Indian Reservations, was made available for settlement in 1854. The First Territorial Legislature established Jefferson County in July 1855 as one of the original 33 counties. Oskaloosa, established as a townsite in 1857, was named the county seat in 1858. The present boundaries were established in 1867.

In 1860, the population of the county was 4,446. By 1870, it had increased to 12,565. According to the 1973 Census of Agriculture, the population was 12,825.

Physiography, Relief, and Drainage

Jefferson County lies within the Dissected Till Plains section of the Central Lowlands physiographic province (*8*). Major topographic features are the east-trending Kansas and south-trending Delaware River Valleys and the upland cuestas formed by differential erosion in the beds of limestone, shale, and sandstone. The northeastern part of the county is a rolling glacial till landscape where loess mantles most of the divides.

The Kansas River and its tributaries drain all of the county. The highest elevation, about 1,160 feet above sea level, is in the western part of the county. The lowest, about 820 feet, is along the Kansas River in the southeastern part. The average gradient of the Kansas River is about 2 feet per mile.

Climate[10]

The climate of Jefferson County is the typical continental type expected in the interior of a large land mass in the middle latitudes. It is characterized by large diurnal and annual variations in temperature. This feature of the climate is similar not only throughout Kansas, but also throughout much of the area between the Rockies to the west and the Appalachian Mountains to the east.

Jefferson County lies in the region classified as moist subhumid by Thornthwaite (*17*). Precipitation often exceeds evapotranspiration, and the surplus either runs off or soaks into the soil and recharges ground water. Although the county is east of the rain shadow of the Rocky Mountains, it frequently receives moisture-laden air currents from the Gulf of Mexico (*4*). Consequently, Jefferson County receives only slightly less precipitation than southeast Kansas, where precipitation is heaviest for the state.

Climatological records have been kept in Jefferson County since the turn of the century. Data have been recorded at Valley Falls, and more recently at Oskaloosa and Perry Dam. The data in table 15, however, are from records kept at Lawrence in nearby Douglas County. They accurately represent climatic conditions in Jefferson County and are available in the Weather Data Library of the Kansas Agricultural Experiment Station.

Annual precipitation in Jefferson County averages 36 to 38 inches. More than 70 percent of this annual total occurs during the growing season, April through September. Measurable amounts of precipitation occur on an average of 95 days of the year. Precipitation falls in May and in June on an average of 11 days and 8 or 9 days in July and in August. The 13 wettest days each year receive fifty percent of the annual rainfall. Therefore, the other 50 percent is light rainfall on 82 days. Although the total annual rainfall is considered adequate for crop production almost every year, the distribution is often erratic. It is not uncommon to have 2 or 3 weeks of dry weather between showers. These dry spells can produce stress conditions in cultivated crops, native pastures, and meadows.

Most of the precipitation is the result of convective shower activity. Thunderstorms moving across the county, usually in the evening or during the night, account for most of the precipitation in summer. Rainfall during these storms is generally intense and of short duration. The intensity is great enough that runoff occurs regularly. Each year, 10 percent of the showers are in amounts exceeding 1 inch. Several showers of more than 3 inches occur in most years. Almost 60 percent of the showers measure less than 0.25 inch.

Annual snowfall averages around 18 to 20 inches in Jefferson County. Amounts are fairly evenly divided during the period December through March. The maximum is generally in February. The snow cover generally does not remain on the ground for more than a week, but there are occasional exceptions. In 1960, the ground was covered with snow for 5 weeks. Snow accumulated to a depth of 20 inches during mid-March of that year. Blizzards are infrequent and of short duration.

Temperature ranges are large in a continental climate. Annual extremes range from below zero to above 100° F. in Jefferson County. These extremes are gen-

[10] By L. DEAN BARK, climatologist, Kansas Agricultural Experiment Station.

TABLE 15.—*Temperature and precipitation*

[Data from Lawrence, Kans.]

Month	Temperature				Precipitation		
	Average daily maximum	Average daily minimum	Two years in 10 will have about 4 days with—		Average total	One year in 10 will have—	
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Total less than—	Total greater than—
	°F	°F	°F	°F	In	In	In
January	39.9	20.6	59.7	0.3	1.10	0.16	2.60
February	45.8	25.1	63.5	9.0	1.18	0.38	2.17
March	54.7	32.4	76.9	15.3	2.40	0.68	4.07
April	68.3	45.4	83.6	31.4	3.76	1.41	6.63
May	77.0	55.2	89.1	42.1	4.23	1.98	6.34
June	84.8	64.2	95.6	54.5	6.04	1.18	10.01
July	89.9	68.3	101.3	59.5	4.68	0.84	8.28
August	89.1	67.1	98.9	57.4	4.20	1.31	7.15
September	81.4	58.3	95.1	45.1	3.76	0.75	6.69
October	71.4	48.2	86.7	33.8	3.04	0.40	5.59
November	55.5	35.0	72.1	19.5	1.57	0.13	4.87
December	43.3	25.2	62.1	8.2	1.44	0.35	2.11
Year	66.9	45.2	101.4	−4.8	37.40	22.36	45.89

erally of short duration and are not important to the overall climate. Extremely cold periods are associated with snow covered ground and clear nights. Fortunately, the snow acts as an insulating blanket for winter wheat, grass, and other dormant plants. The average temperatures listed in table 15 illustrate the rather short transitional seasons of spring and fall that occur in Kansas. From December through February the average daily temperature is in the 30's. Warm temperatures necessary for plant growth continue from late in April to early in October. The average growing season, or frost-free period, is 180 days in Jefferson County (*3*). The probabilities of freezes of differing severity in spring and fall are shown in table 16.

The prevailing wind direction is southerly except in January and February when northerly winds are more frequent and in March when winds tend to be easterly. Winds in northeast Kansas are generally of less velocity than those in the western part of the state. Strong, blustery winds occur at times, particularly late in winter and early in spring.

Tornadoes and severe windstorms occur occasionally in Jefferson County, but are usually local and of short duration. Jefferson County is far removed from the center of maximum hail damage, which is in the northwestern part of the State.

Droughts are not uncommon in northeast Kansas. Droughts classified as mild, moderate, severe, or extreme were recorded during the period 1931–1968 (*7*). Severe or extreme droughts occurred in 52 months, or 11 percent of the total period. This percentage most likely is higher than average since the period of study was selected to compare the well-known droughts of the 1930's and 1950's. A longer period of study might reduce the percentage of time in which severe and extreme drought conditions existed, but the potential still exists.

Water Supply

The Kansas and Delaware River Valleys are the most important sources of ground water. The best potential for large supplies of water is from wells drilled in the Kansas River Valley.

Small to moderate supplies of ground water are available in areas of thick glacial deposit in the northeastern part of Jefferson County. Other upland areas of the county have limited potential for ground water development.

Only small quantities of water are available from bedrock formations in this county (*23*).

Natural Vegetation

About 15 to 20 percent of Jefferson County was originally woodland. The original vegetation on most of the uplands was tall prairie grass. The original vegetation on the bottom land and along small drainageways was a lowland plains hardwood association and in some poorly drained areas, water-tolerant tall prairie grass.

The present vegetation on uplands that are grazed is an overutilized savannah of poor quality woody plants and an understory of mainly weeds and only a small percentage of tall prairie grasses. About 5,000 acres of the uplands is well managed, and the plant cover is dominantly big and little bluestem.

The present vegetation on the bottom land that is not cultivated is somewhat like the original vegetation, but the more desirable trees have been harvested.

Industry and Natural Resources

Industries are small and few in number. Businesses that service and sell farm machinery and other farm supplies are located in the area.

TABLE 16.—*Probabilities of last freezing temperature in spring and first in fall*

[Data from Oskaloosa, Kans.]

Probability	Dates for given probability and temperature				
	16°F or lower	20°F or lower	24°F or lower	28°F or lower	32°F or lower
Spring:					
1 year in 10 later than	March 27	April 5	April 11	April 20	May 4
2 years in 10 later than	March 21	March 30	April 6	April 15	April 29
5 years in 10 later than	March 9	March 20	March 28	April 5	April 19
Fall:					
1 year in 10 earlier than	November 12	November 4	October 24	October 14	October 7
2 years in 10 earlier than	November 18	November 9	October 28	October 19	October 11
5 years in 10 earlier than	November 30	November 20	November 7	October 28	October 21

Water is the most important natural resource. Other natural resources are sand, gravel, and limestone. Sand and gravel are available from the Kansas River. Limestone is quarried and then crushed for use in making concrete and surfacing roads. Some of the crushed limestone is used as agricultural lime. There are several operating limestone quarries in Jefferson County.

Markets for agricultural products are readily available. Most crops are sold to local buyers in Jefferson and surrounding counties. Most of the livestock is marketed locally or in Kansas City and St. Joseph, Missouri.

Transportation Facilities

Jefferson County is served by main and branch lines of railroads. Air service is available in Topeka and Lawrence to Kansas City International Airport. U.S. Highway 24 crosses the southern part of the county in an east-west direction. U.S. Highway 59 crosses the central part in a north-south direction. Kansas Highway 16 crosses the county from southeast to northeast, and Kansas Highway 4 from northeast to southwest. Kansas Highway 192 enters the county east of Winchester and intersects U.S. Highway 59. Kansas Highway 92 enters the county northeast of McLouth and intersects Kansas Highway 4 west of Ozawkie.

Community Facilities

All rural areas of Jefferson County are in unified elementary and high school districts. Telephone service and electricity is available to all residents in the county. Natural gas is available in all of the incorporated communities. Hospital facilities are available in Winchester.

Many types of recreational facilities are available, including golf courses, parks, and lakes for water sports.

Land Use and Trends

The farming in this county is based on cash crops and livestock. About 50 percent of the agricultural income in 1972 was from cash crop products (*11*). The present trend is a decrease in crop acreage: 146,000 acres of crops was harvested in 1962, and 129,400 acres in 1972 (*10, 11*).

About 50 percent of the agricultural income in 1972 was from livestock products (*11*). The present trend is stable for livestock, both cattle and hogs, and a small increase in the acreage used for pasture and hay (*9, 10, 11*).

The present trend is an increase in population in Jefferson County. The population totaled 11,261 in 1960; 12,147 in 1970; and 12,825 in 1973.

The future trend in land use will be a gradual decrease in the acreage farmed and an increase in the acreage under urban development or other nonfarm use.

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Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single mapping unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Complex, soil. A mapping unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Drainage class (natural) Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially

drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or B horizon.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—few, common, and many; size—fine, medium, and coarse; and contrast—faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the bases of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Poorly graded. Refers to soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH		pH
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are

unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand, or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface layer. Technically, the A1 or Ap horizon.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Well graded. Refers to a soil or soil material consisting of particles well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

GUIDE TO MAPPING UNITS

Map symbol	Mapping unit	Page	Capability unit	Range site	Pasture suitability group	Woodland suitability group
			Symbol	Name	Symbol	Symbol
Ec	Eudora complex, overwash	8	IIw-1	Loamy Lowland	A-1	2o
Gb	Grundy silty clay loam, 0 to 2 percent slopes	9	IIe-1	Loamy Upland	A-2	--
Gc	Grundy silty clay loam, 2 to 5 percent slopes	9	IIIe-2	Loamy Upland	A-2	--
Gy	Gymer silt loam, 3 to 7 percent slopes	10	IIIe-1	Loamy Upland	A-2	--
Hc	Haig silty clay loam	10	IIs-1	Clay Upland	C	--
Ju	Judson silt loam	11	I-1	Loamy Lowland	A-1	2o
Kb	Kennebec silt loam	11	IIw-2	Loamy Lowland	A-1	2o
Kc	Kennebec soils, channeled	11	VIw-1	Loamy Lowland	A-1	2o
Km	Kimo silty clay loam	12	IIw-3	Clay Lowland	E	3o
Ko	Kimo-Eudora complex	12	IIw-1	-------------	---	--
	Kimo soil	--	------	Clay Lowland	E	3o
	Eudora soil	--	------	Loamy Lowland	A-1	2o
Kv	Konawa complex, 4 to 10 percent slopes	13	IVe-1	Savannah	B	3o
Mb	Martin silty clay loam, 1 to 3 percent slopes	13	IIe-1	Loamy Upland	A-2	--
Mc	Martin silty clay loam, 3 to 8 percent slopes	13	IIIe-2	Loamy Upland	A-2	--
Mh	Martin soils, 3 to 8 percent slopes, eroded	14	IVe-4	Clay Upland	C	--
Mo	Martin-Oska silty clay loams, 3 to 6 percent slopes	14	IVe-3	Loamy Upland	A-2	--
Mv	Morrill loam, 3 to 7 percent slopes	14	IIIe-1	Loamy Upland	A-2	--
Oc	Oska silty clay loam, 2 to 6 percent slopes	15	IIIe-1	Loamy Upland	A-2	--
Pb	Pawnee clay loam, 1 to 3 percent slopes	15	IIe-1	Loamy Upland	A-2	--
Pc	Pawnee clay loam, 3 to 7 percent slopes	15	IIIe-2	Loamy Upland	A-2	--
Ph	Pawnee soils, 3 to 7 percent slopes, eroded	16	IVe-4	Clay Upland	C	--
Re	Reading silt loam	16	I-1	Loamy Lowland	A-1	2o
Sb	Sarpy-Eudora complex, overwash	17	IIIw-2	-------------	---	--
	Sarpy soil	--	------	Sandy Lowland	B	5s
	Eudora soil	--	------	Loamy Lowland	A-1	2o
Sc	Shelby-Pawnee complex, 3 to 8 percent slopes	17	IIIe-1	Loamy Upland	A-2	--
So	Shelby-Pawnee complex, 8 to 12 percent slopes	17	IVe-5	Loamy Upland	A-2	--
Ss	Sibleyville complex, 3 to 7 percent slopes	18	IVe-2	Loamy Upland	G	--
Sv	Sibleyville complex, 7 to 12 percent slopes	18	VIe-1	Loamy Upland	G	--
Sw	Sogn-Vinland complex, 5 to 20 percent slopes	19	VIe-2	-------------	H	--
	Sogn soil	--	------	Shallow Limy	---	--
	Vinland soil	--	------	Loamy Upland	---	--
Vc	Vinland complex, 3 to 7 percent slopes	20	IVe-3	Loamy Upland	G	--
Vo	Vinland complex, 7 to 15 percent slopes	20	VIe-1	Loamy Upland	G	--
Vx	Vinland-Rock outcrop complex, 20 to 40 percent slopes	20	VIIe-1	Break	H	--
Wc	Wabash silty clay loam	20	IIw-3	Clay Lowland	E	4w
Wh	Wabash silty clay	21	IIIw-1	Clay Lowland	E	4w

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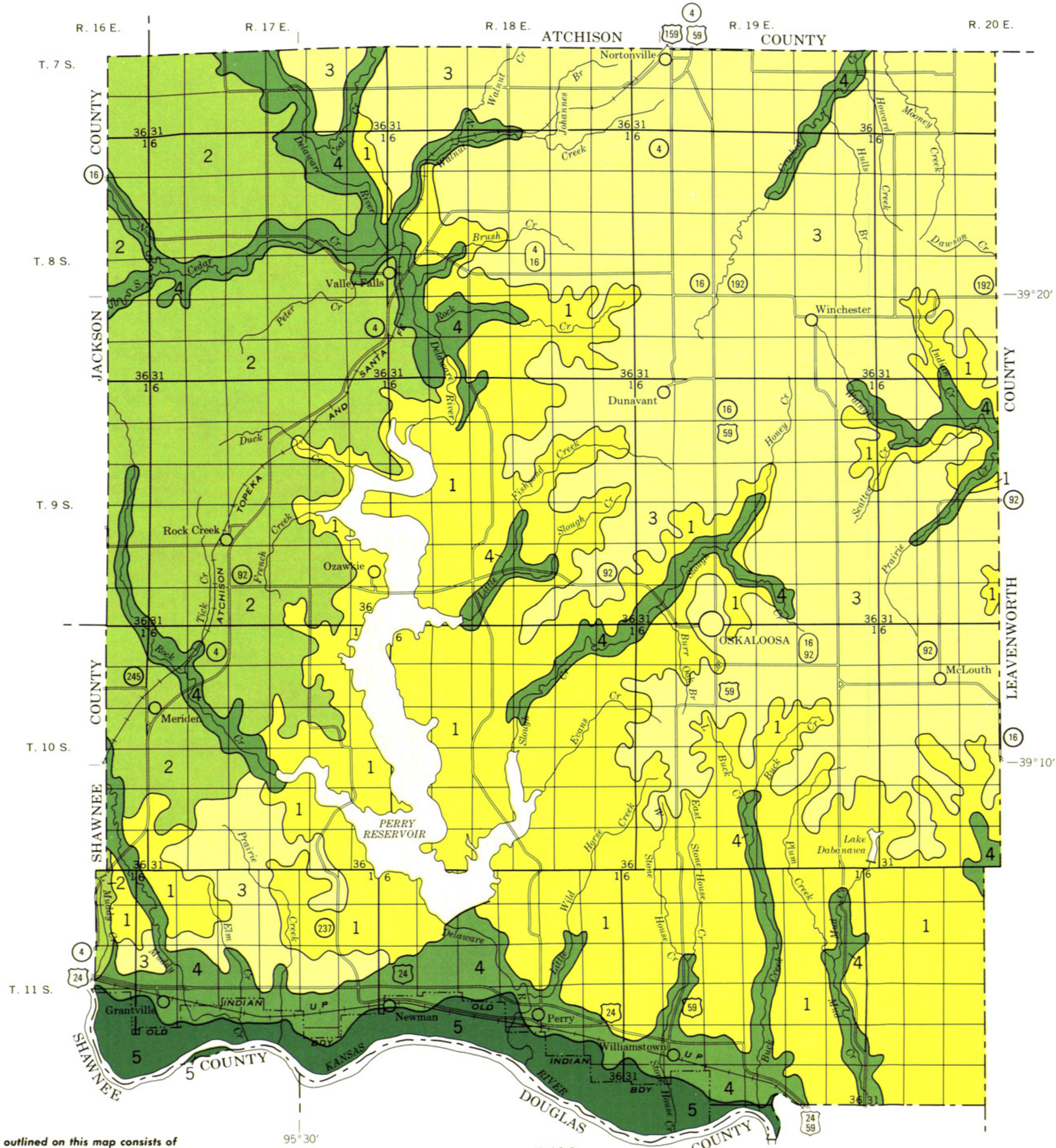


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
JEFFERSON COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 4 Miles

SOIL ASSOCIATIONS

1 Martin-Vinland-Sogn association: Deep, moderately well drained, gently sloping to moderately sloping soils and shallow, moderately sloping to steep, somewhat excessively drained soils; on uplands

2 Pawnee-Martin-Vinland association: Deep, moderately well drained, gently sloping to strongly sloping soils and shallow, somewhat excessively drained, moderately sloping to steep soils; on uplands

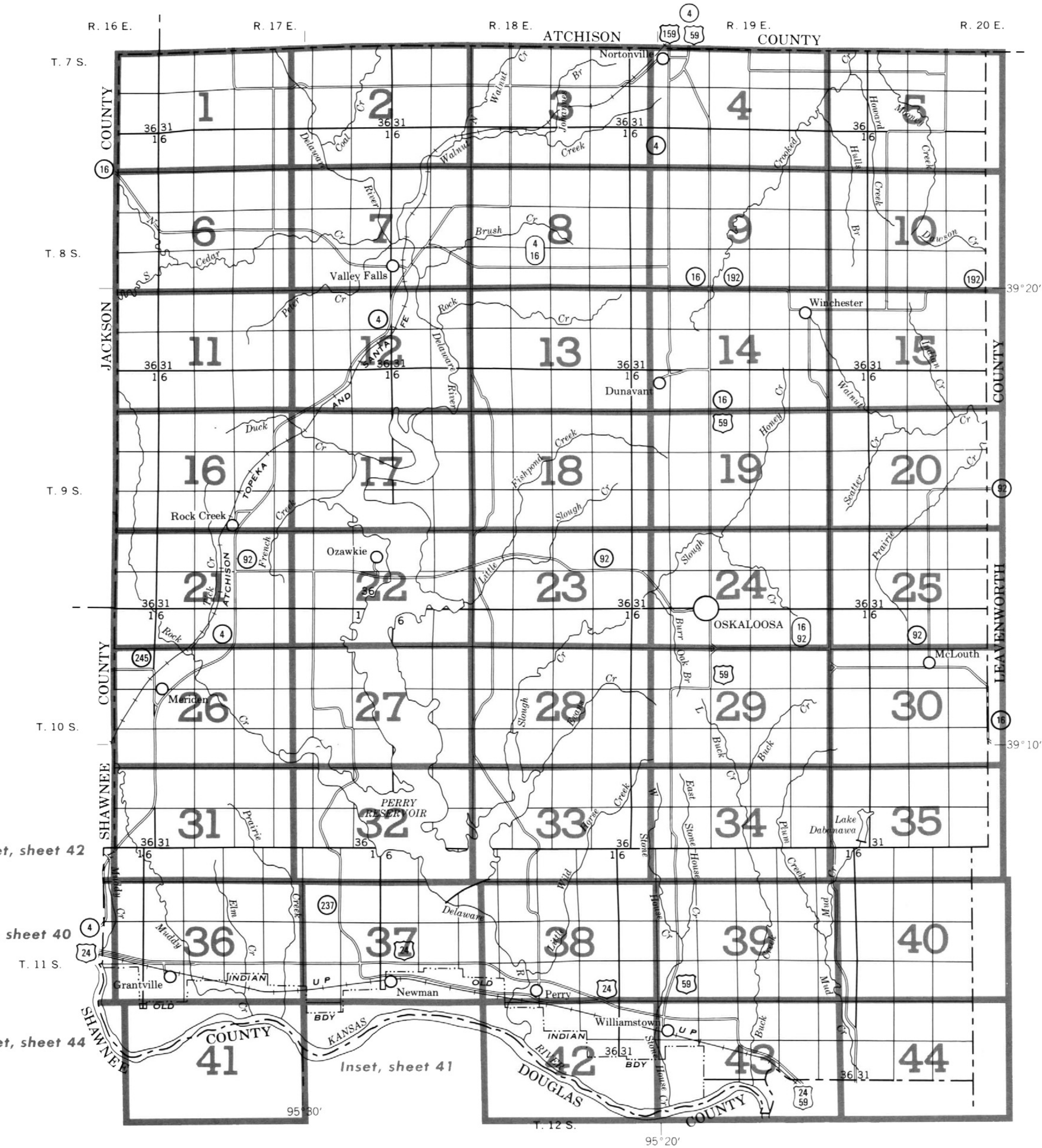
3 Pawnee-Grundy-Shelby association: Deep, nearly level to strongly sloping, well drained to somewhat poorly drained soils on uplands

4 Kennebec-Wabash-Reading association: Deep, nearly level, well drained to very poorly drained soils on bottom lands

5 Eudora-Kimo association: Deep, nearly level to gently undulating, well drained and somewhat poorly drained soils on bottom lands

Compiled 1976

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS

JEFFERSON COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 4 Miles

SOIL LEGEND

The publication symbols are without slope or erosion designation and each symbol represents a different mapping unit.

SYMBOL	NAME
Ec	Eudora complex, overwash
Gb	Grundy silty clay loam, 0 to 2 percent slopes
Gc	Grundy silty clay loam, 2 to 5 percent slopes
Gy	Gymer silt loam, 3 to 7 percent slopes
Hc	Haig silty clay loam
Ju	Judson silt loam
Kb	Kennebec silt loam
Kc	Kennebec soils, channeled
Km	Kimo silty clay loam
Ko	Kimo-Eudora complex
Kv	Konawa complex, 4 to 10 percent slopes
Mb	Martin silty clay loam, 1 to 3 percent slopes
Mc	Martin silty clay loam, 3 to 8 percent slopes
Mh	Martin soils, 3 to 8 percent slopes, eroded
Mo	Martin-Oska silty clay loams, 3 to 6 percent slopes
Mv	Morrill loam, 3 to 7 percent slopes
Oc	Oska silty clay loam, 2 to 6 percent slopes
Pb	Pawnee clay loam, 1 to 3 percent slopes
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So	Shelby-Pawnee complex, 8 to 12 percent slopes
Ss	Sibleyville complex, 3 to 7 percent slopes
Sv	Sibleyville complex, 7 to 12 percent slopes
Sw	Sogn-Vinland complex, 5 to 20 percent slopes
Vc	Vinland complex, 3 to 7 percent slopes
Vo	Vinland complex, 7 to 15 percent slopes
Vx	Vinland-Rock outcrop complex, 20 to 40 percent slopes
Wc	Wabash silty clay loam
Wh	Wabash silty clay

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool (Davis Airstrip; FLOOD POOL LINE)

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate (79)
- Federal (410)
- State (52)
- County, farm or ranch (378)

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small (water; w)

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial (water; w)
- Intermittent (int; i)

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS (CeA; FoB2)

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

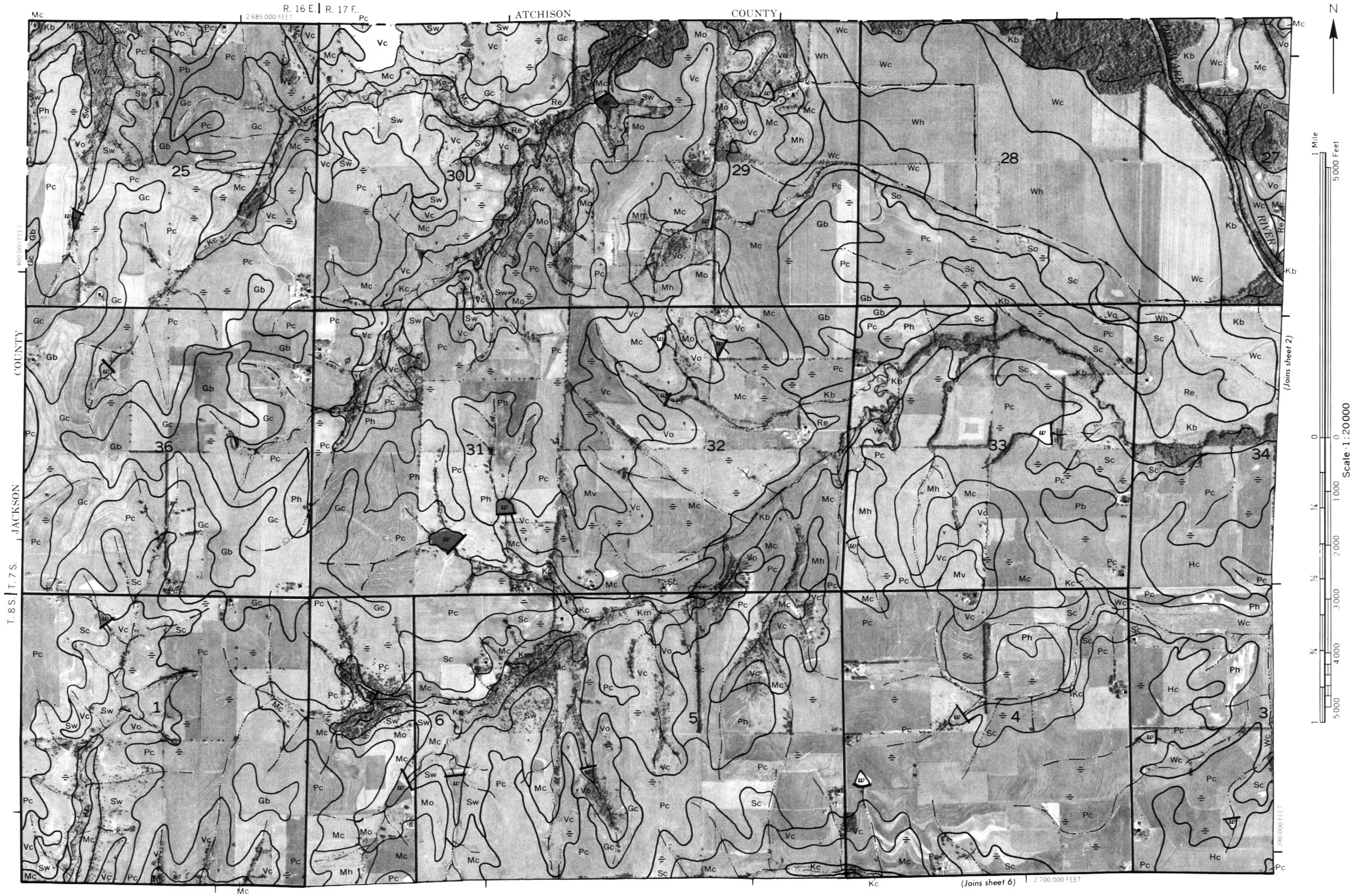
GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

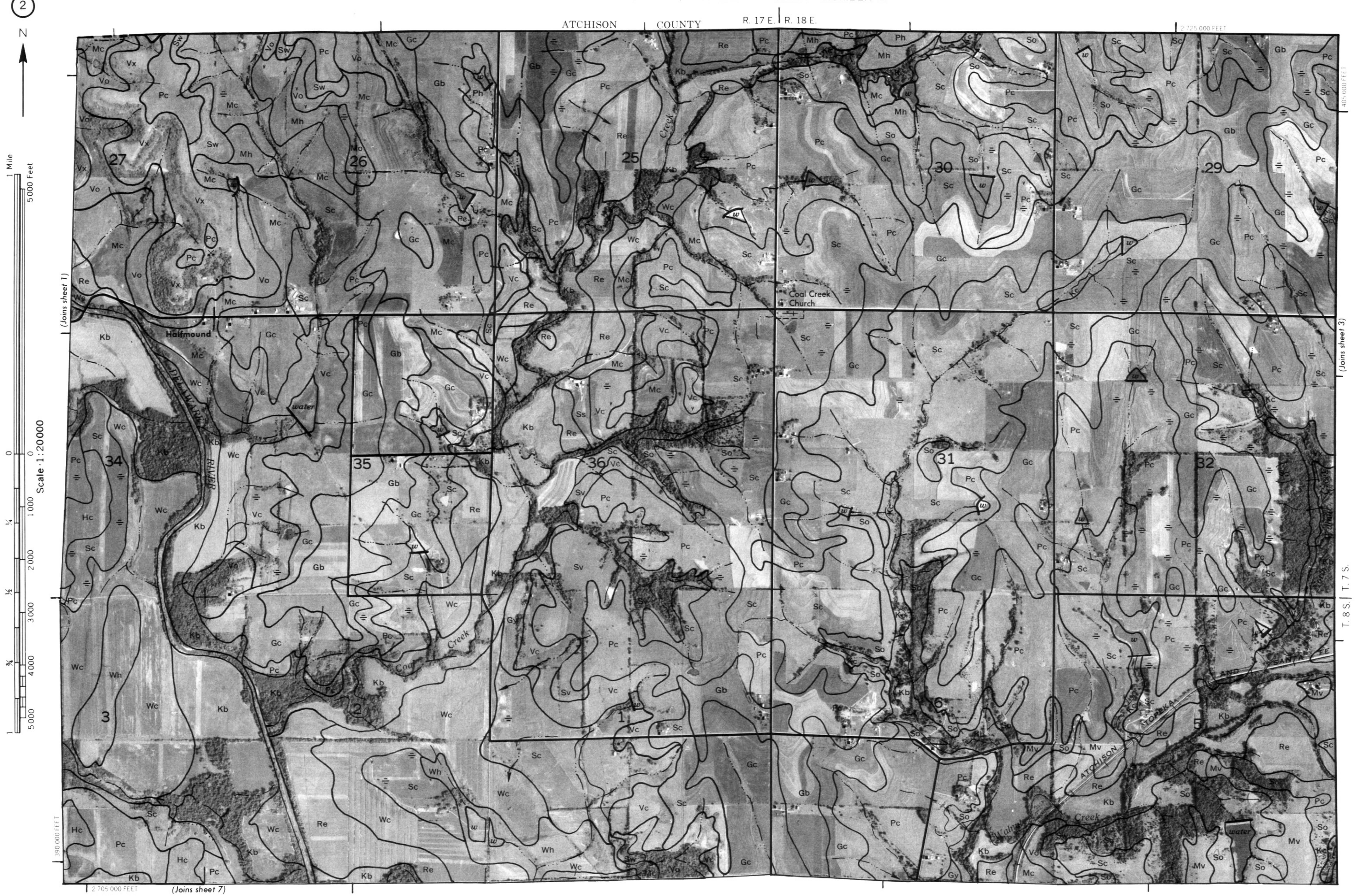
- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Borrow pit — B.P.



JEFFERSON COUNTY, KANSAS NO. 1

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JEFFERSON COUNTY, KANSAS — SHEET NUMBER 2



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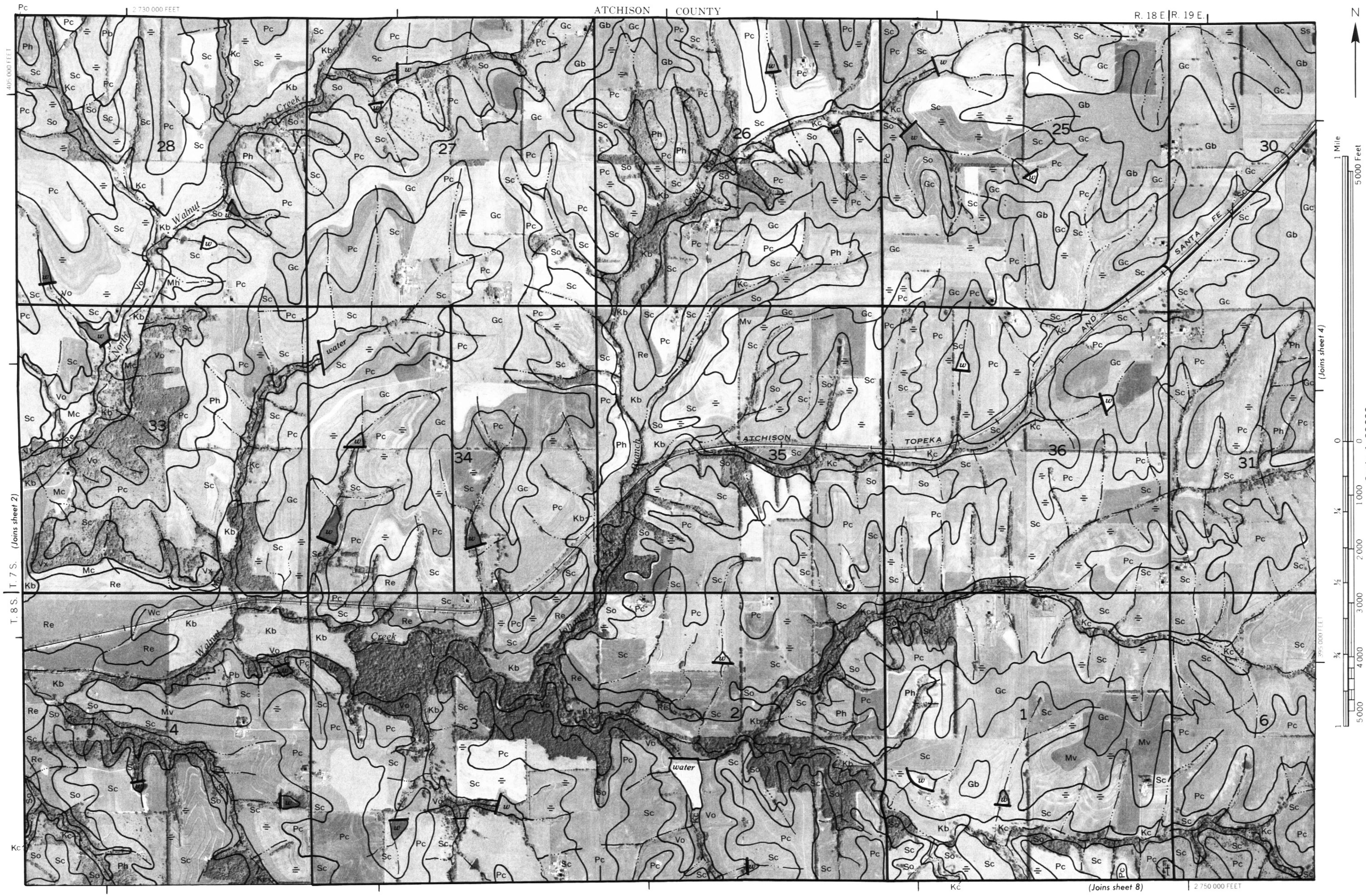

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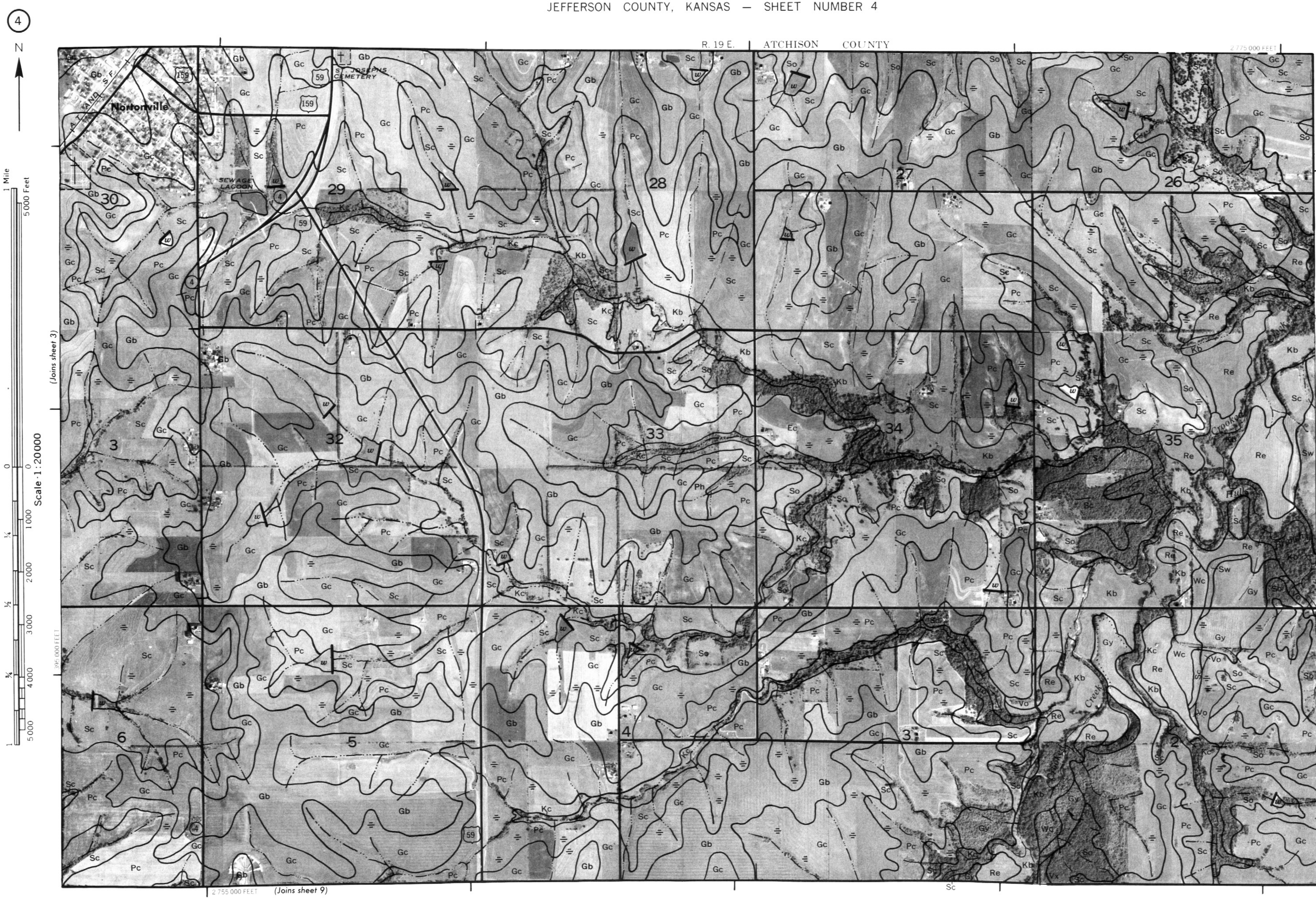

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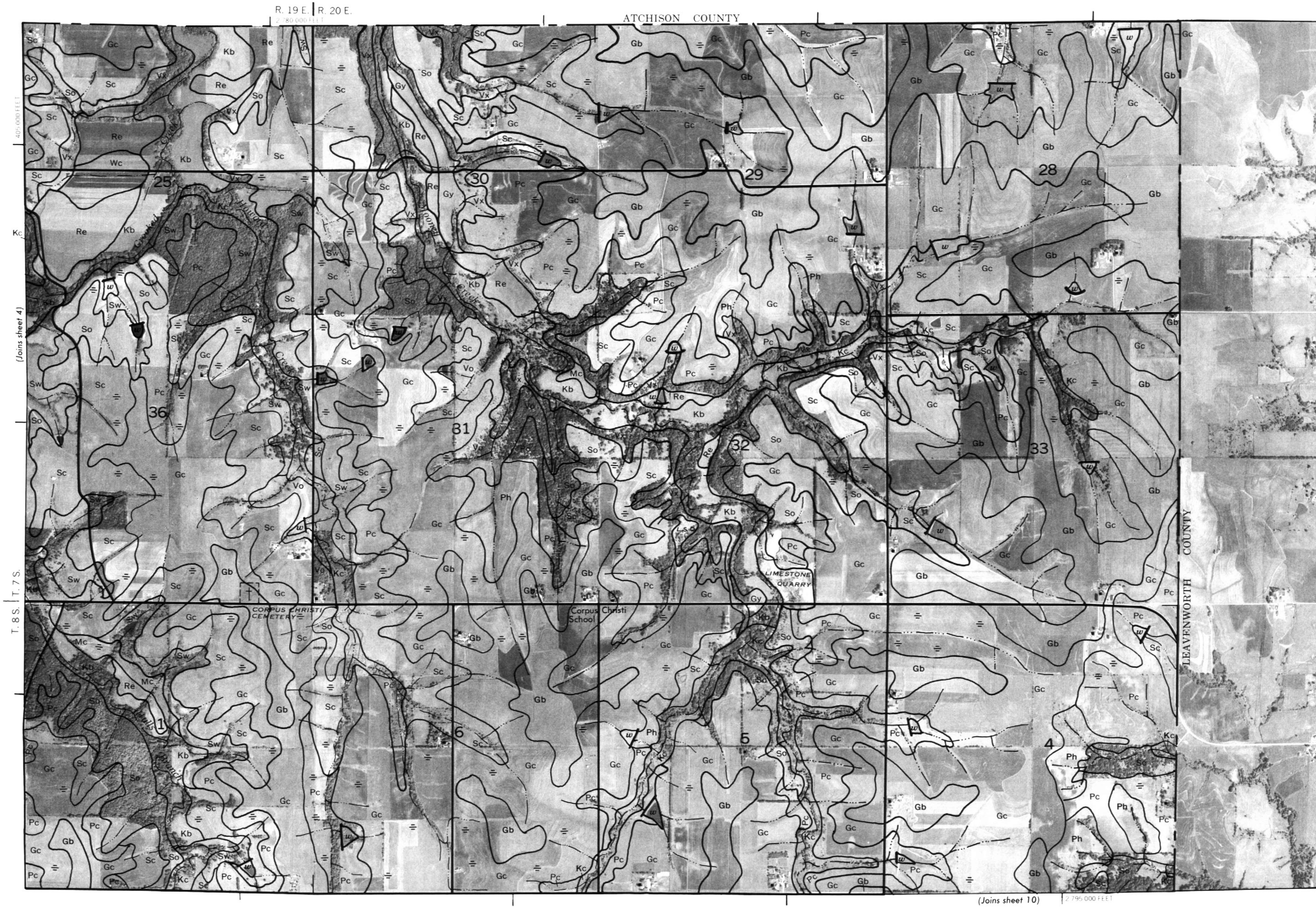
JEFFERSON COUNTY, KANSAS NO. 4

JEFFERSON COUNTY, KANSAS — SHEET NUMBER 5

5



N

1 Mile
5000 Feet
Scale 1:20 000

JEFFERSON COUNTY, KANSAS NO. 5

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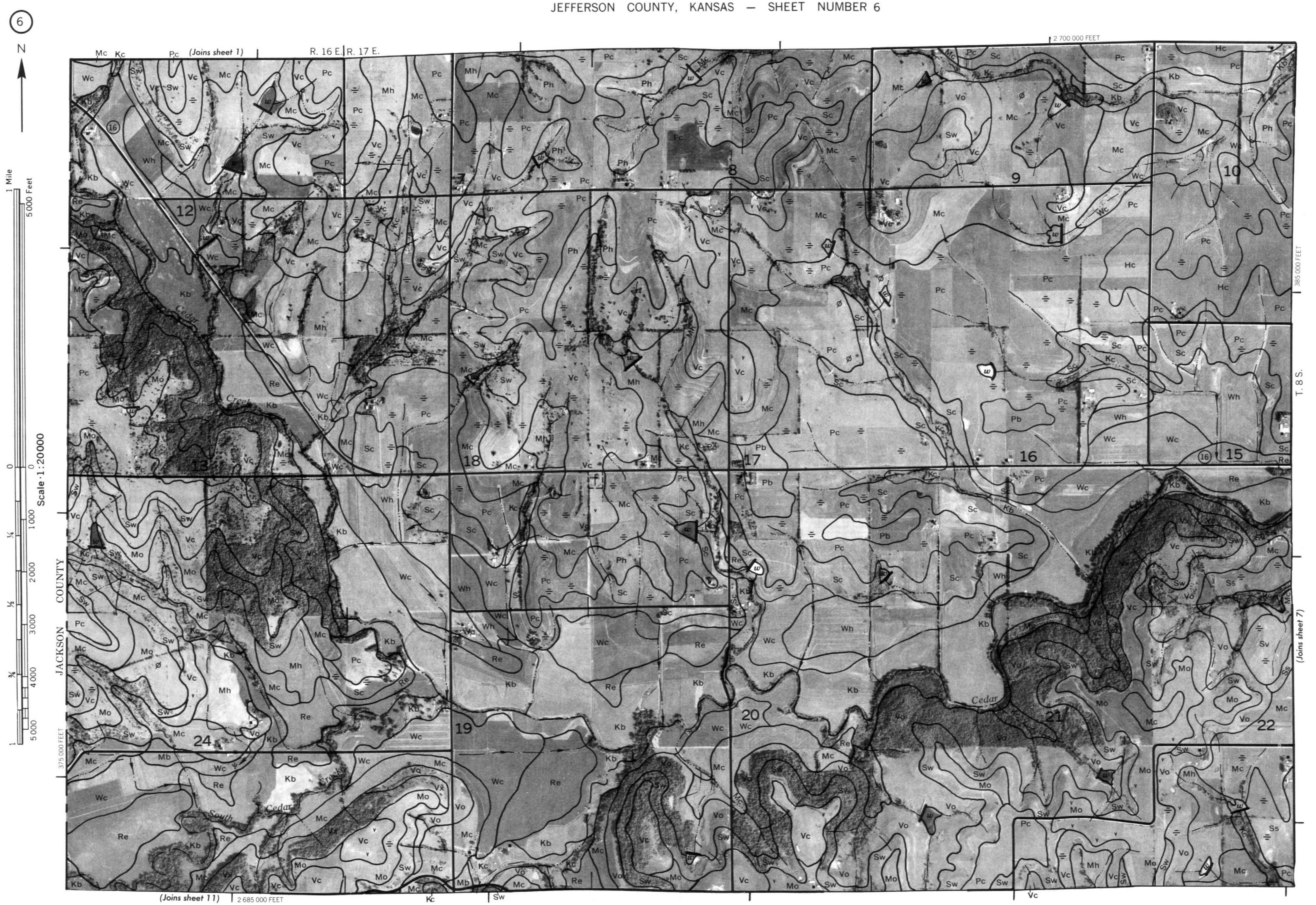

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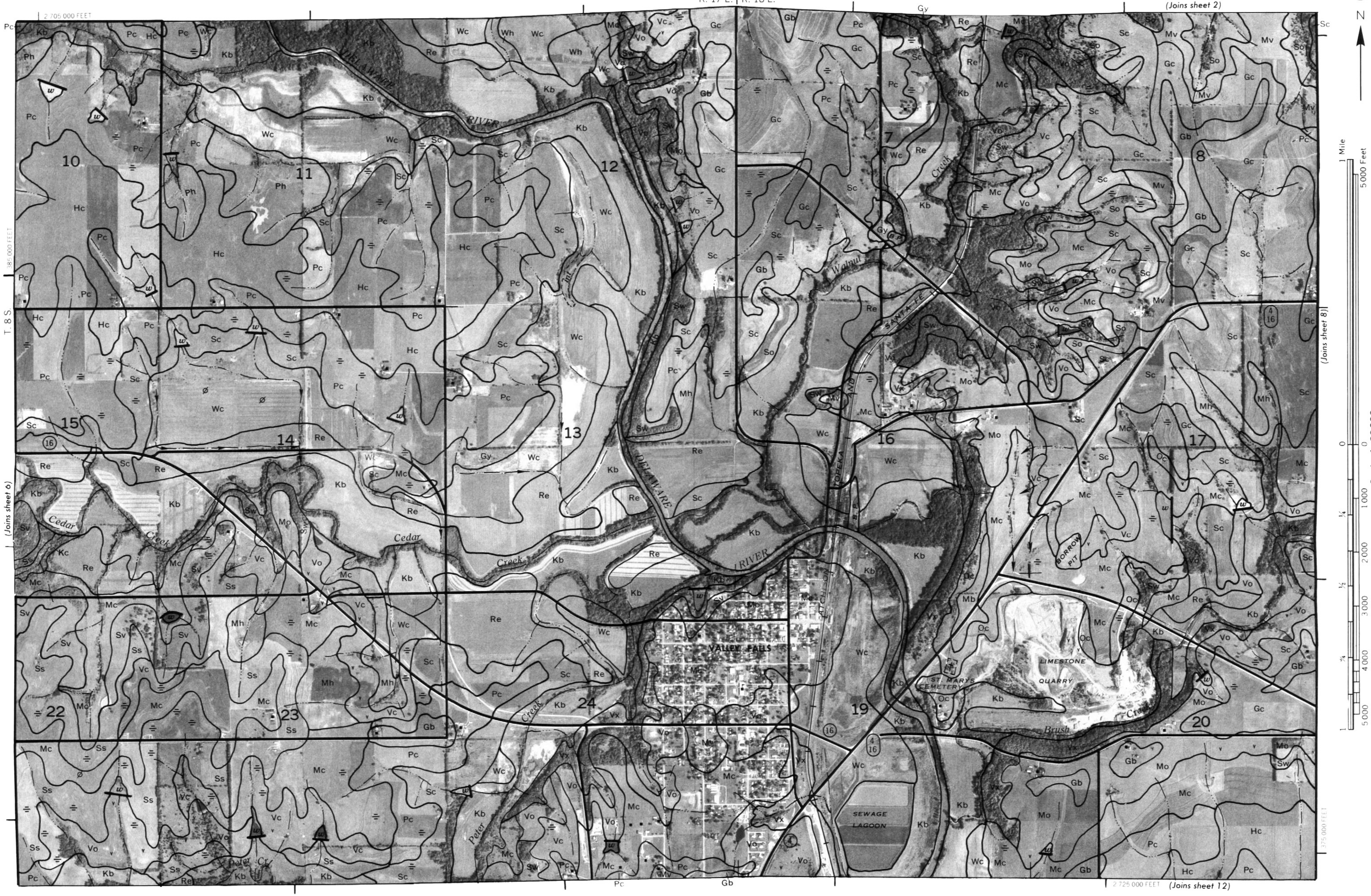

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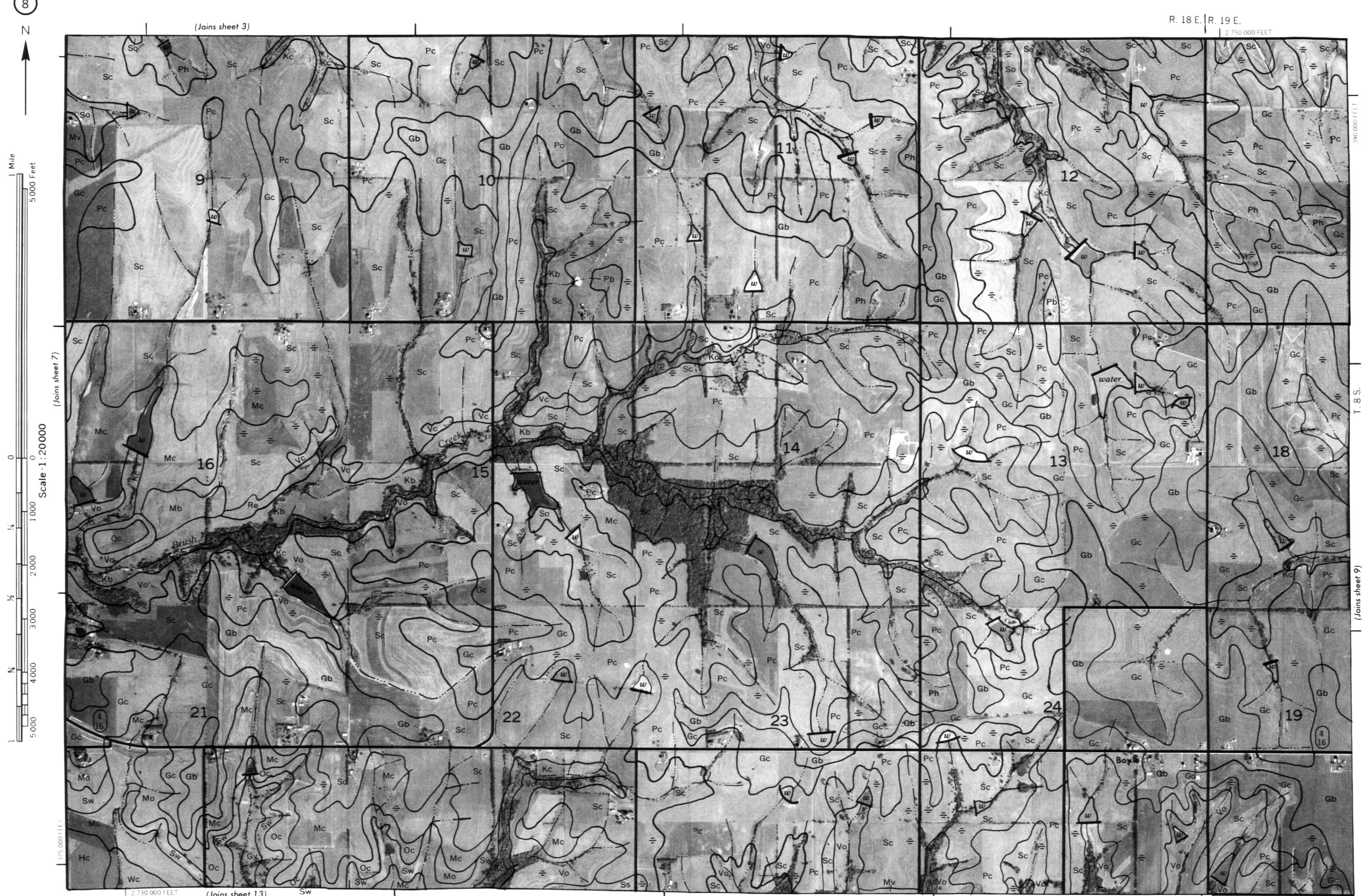
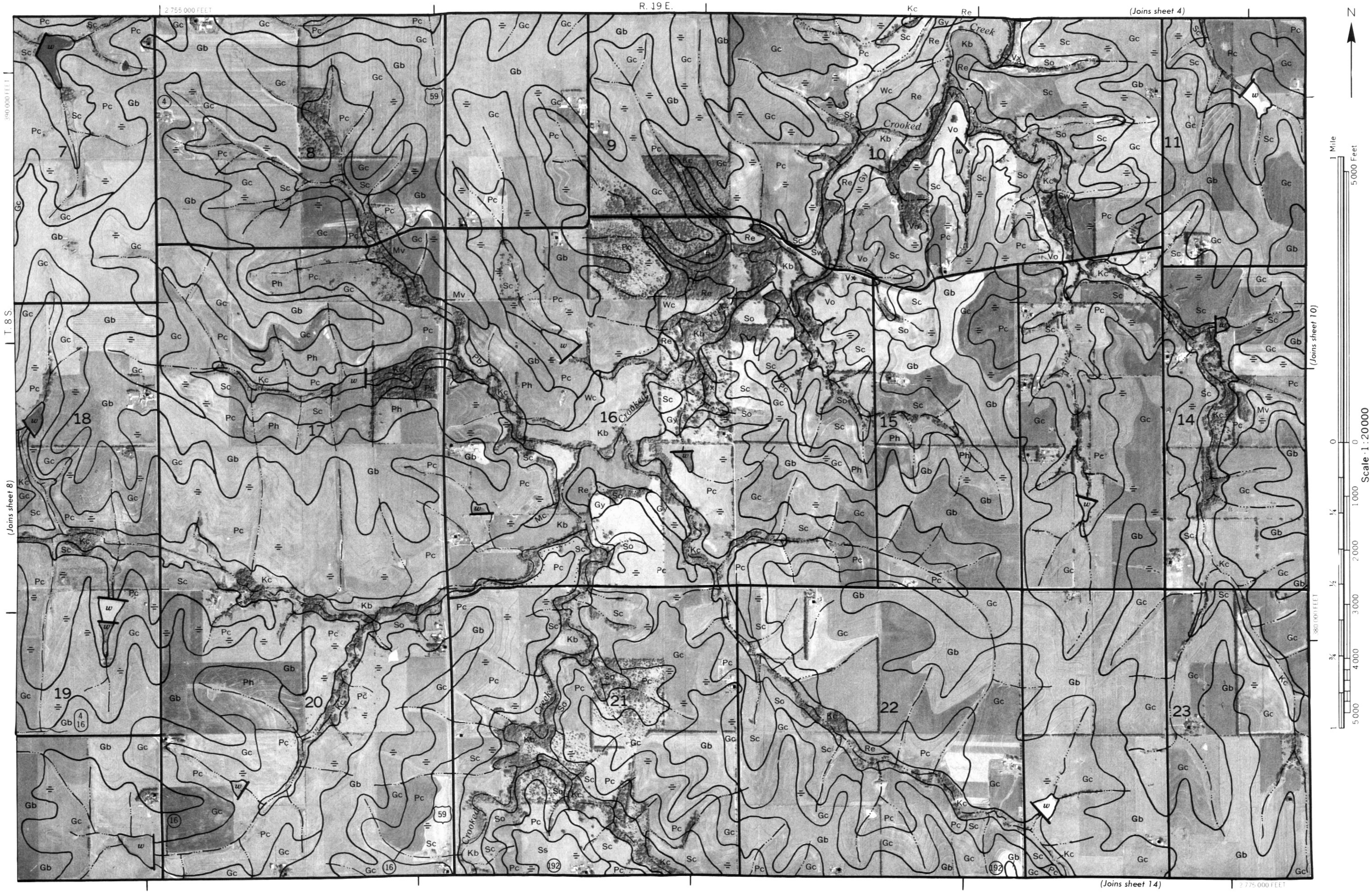
JEFFERSON COUNTY, KANSAS — SHEET NUMBER 8



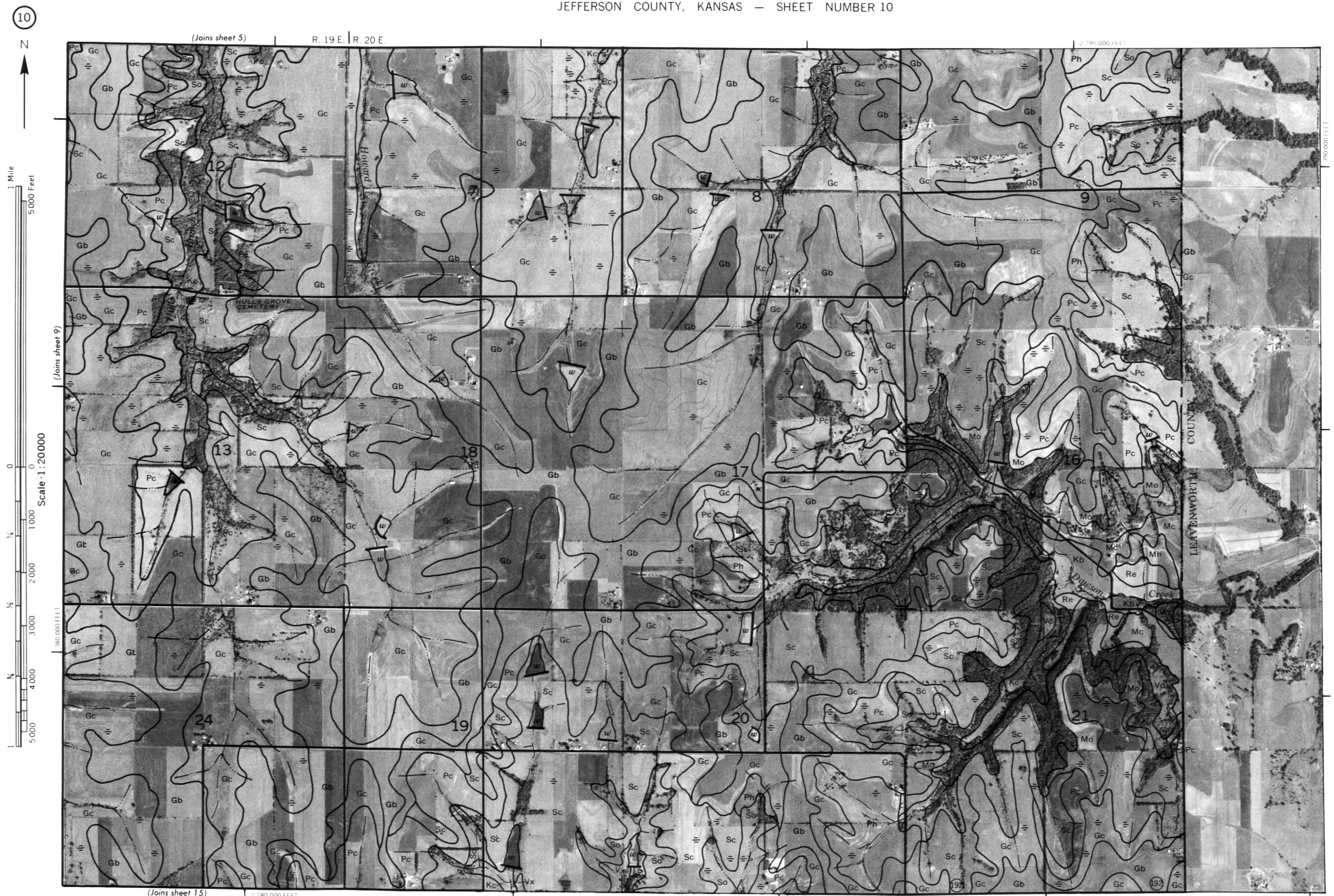
JEFFERSON COUNTY, KANSAS NO. 8

9



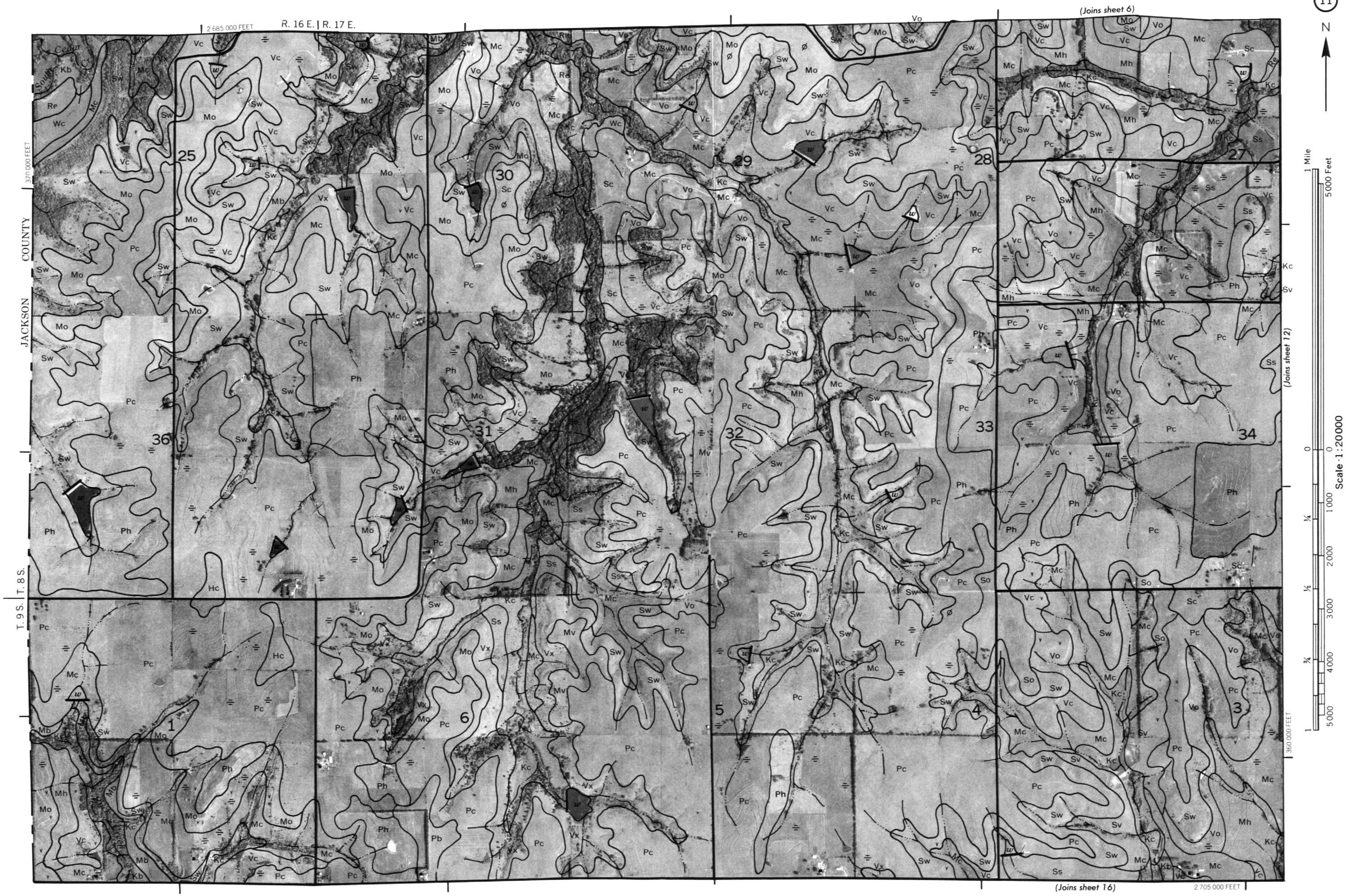
JEFFERSON COUNTY, KANSAS NO. 9

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

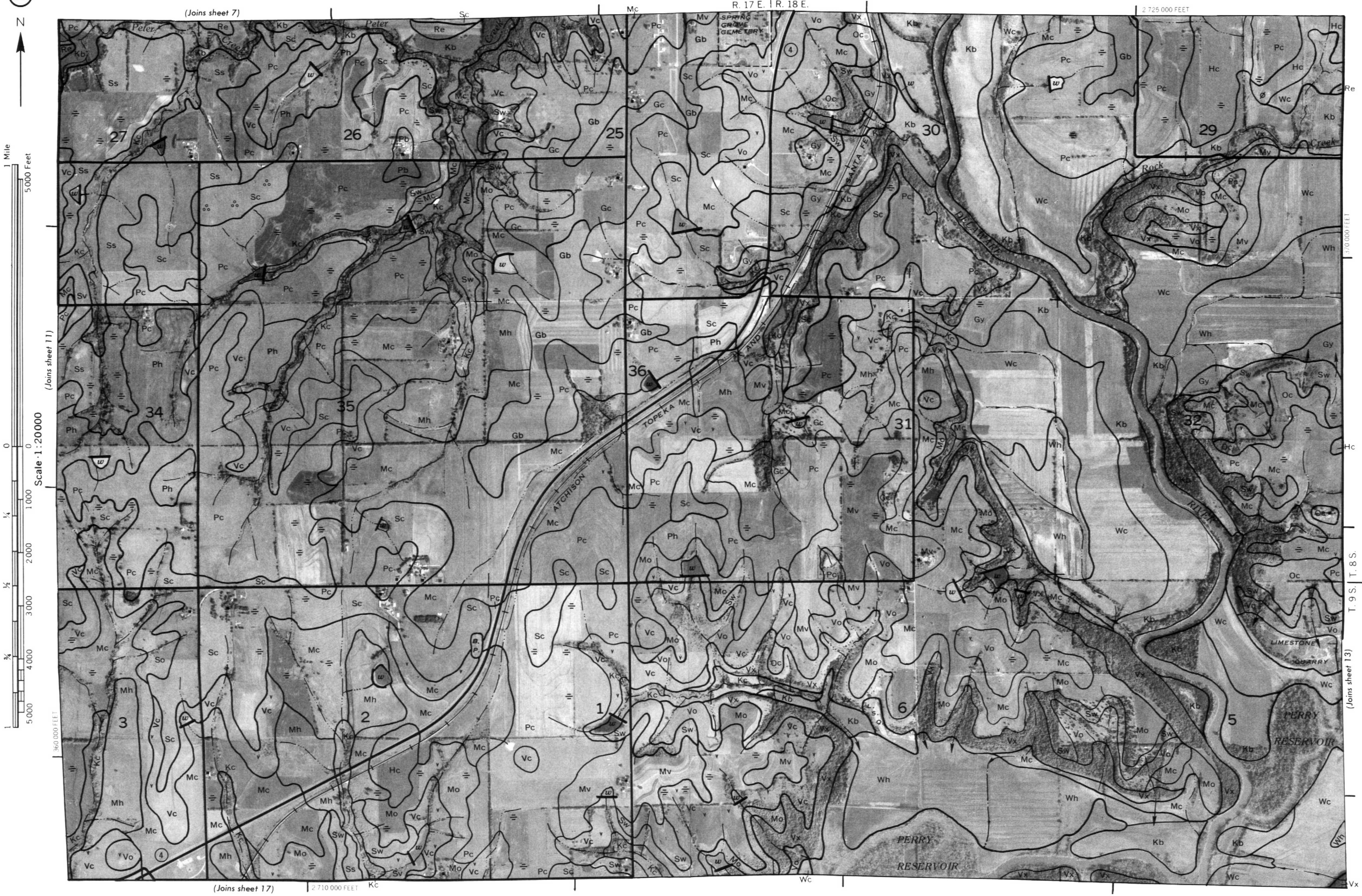
JEFFERSON COUNTY, KANSAS NO. 10



JEFFERSON COUNTY, KANSAS NO. 11

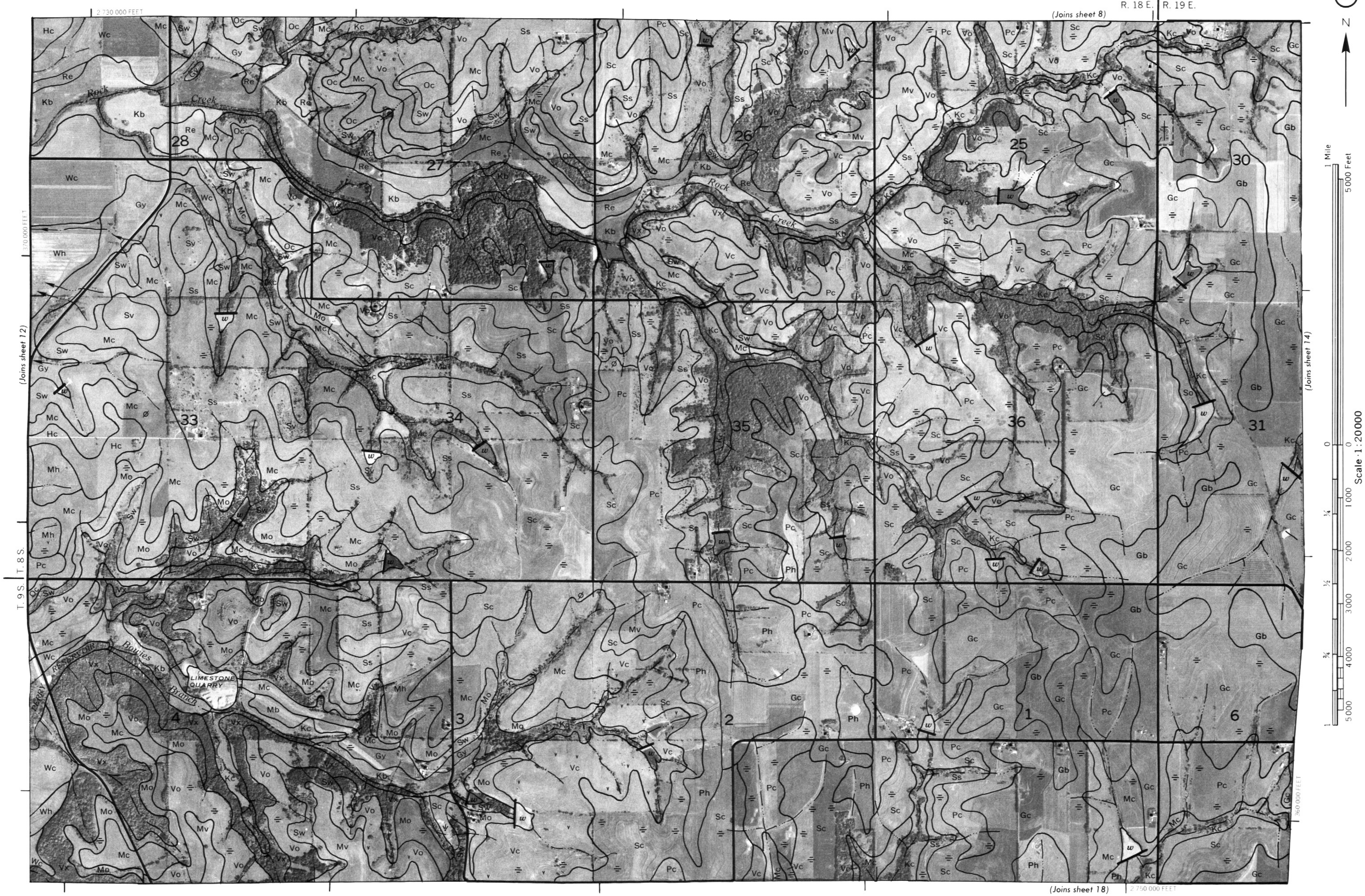
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JEFFERSON COUNTY, KANSAS — SHEET NUMBER 12



JEFFERSON COUNTY, KANSAS NO. 12

This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



JEFFERSON COUNTY, KANSAS NO. 13

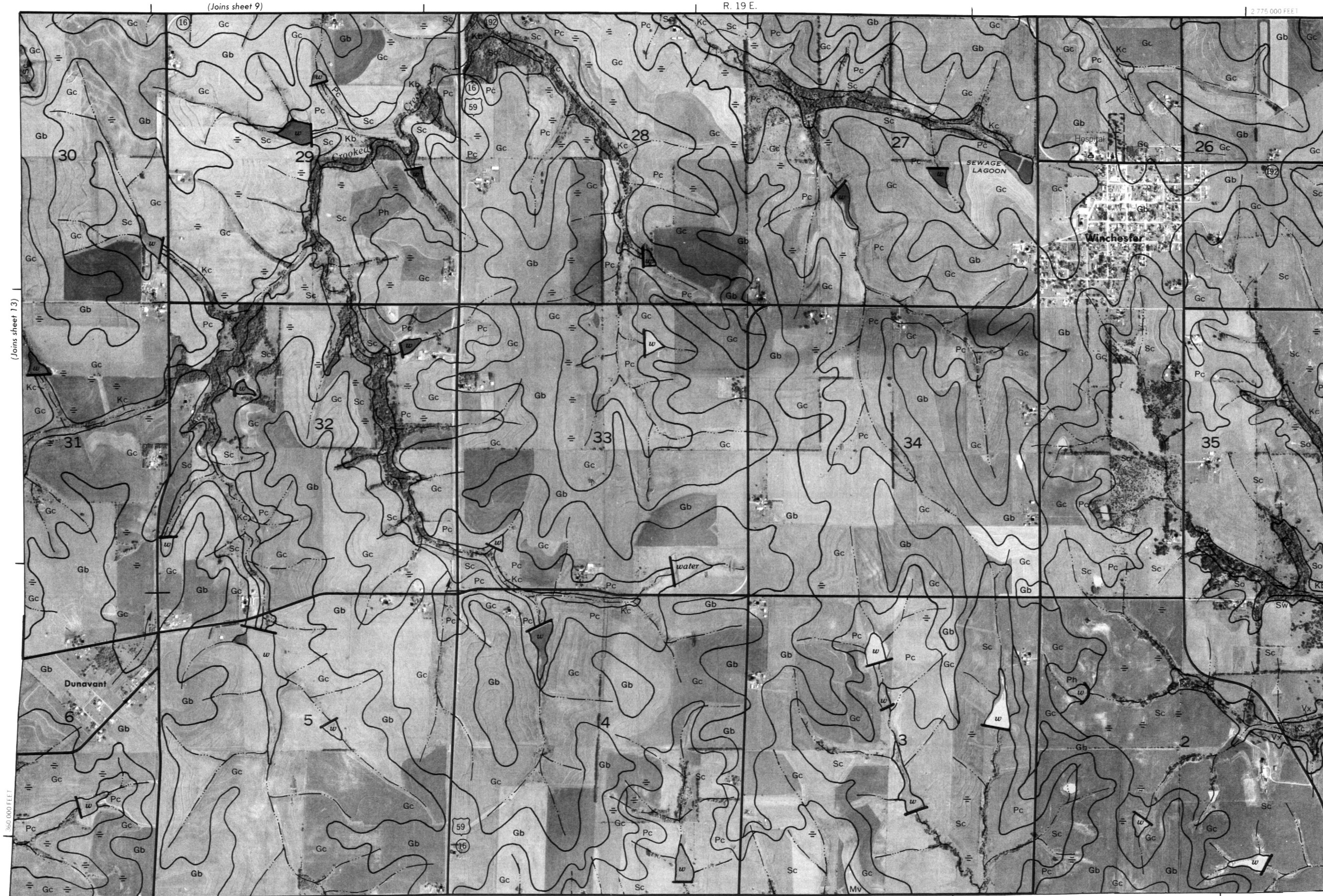
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(14)

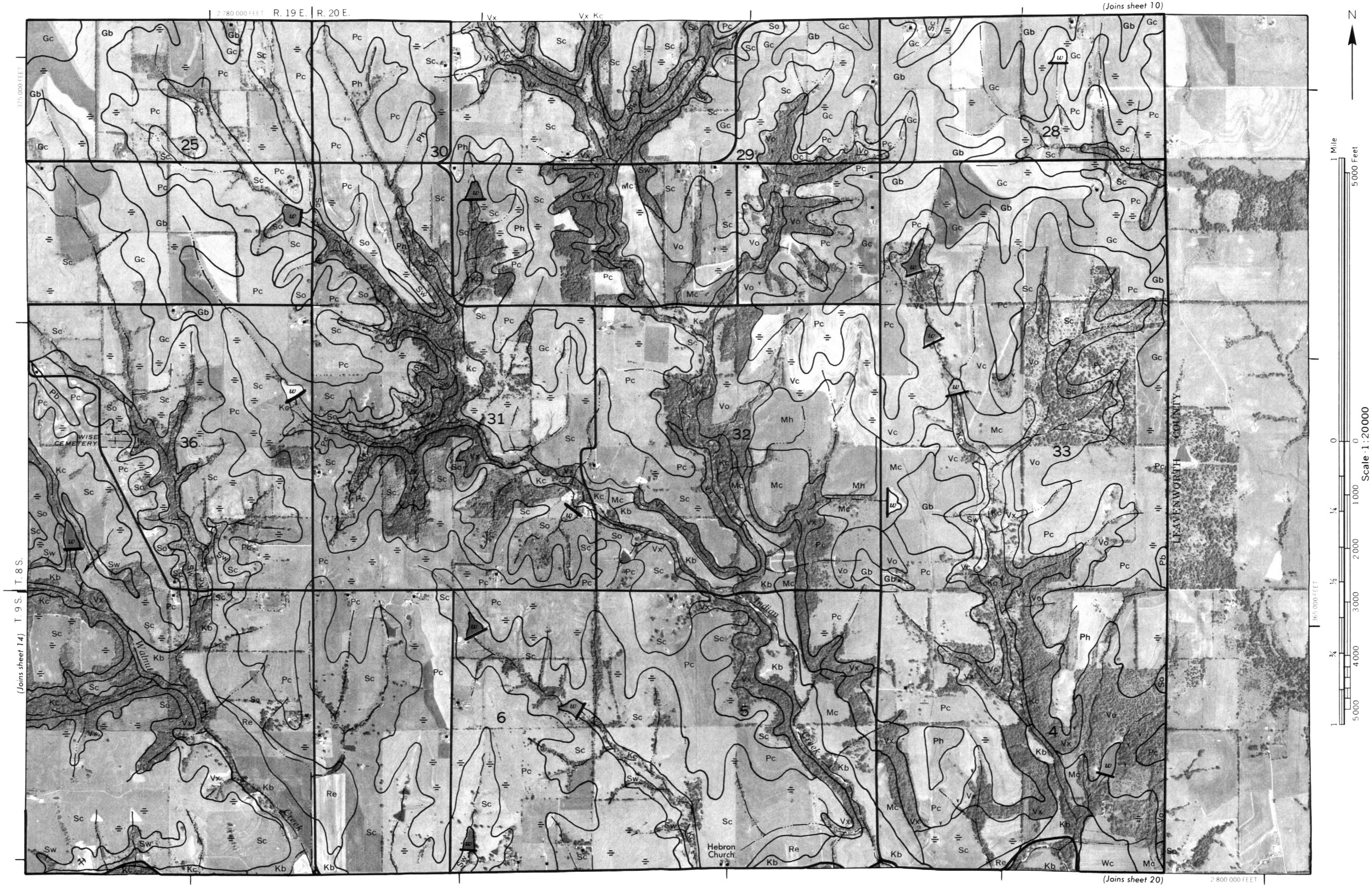
JEFFERSON COUNTY, KANSAS — SHEET NUMBER 14

N

1 Mile
5000 Feet
Scale 1:20000
0 1000 2000 3000 4000 5000



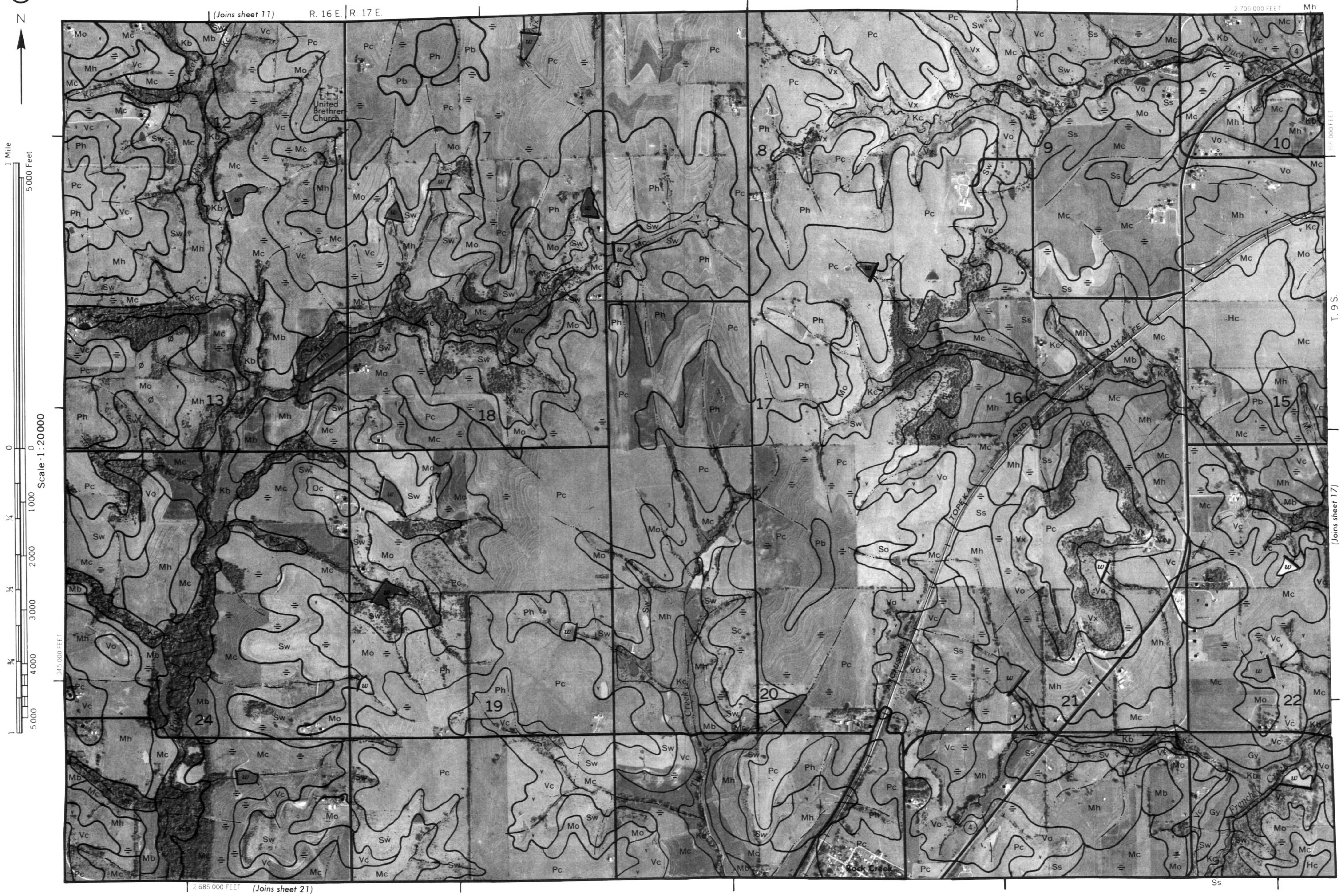
JEFFERSON COUNTY, KANSAS NO. 14



JEFFERSON COUNTY, KANSAS NO. 15

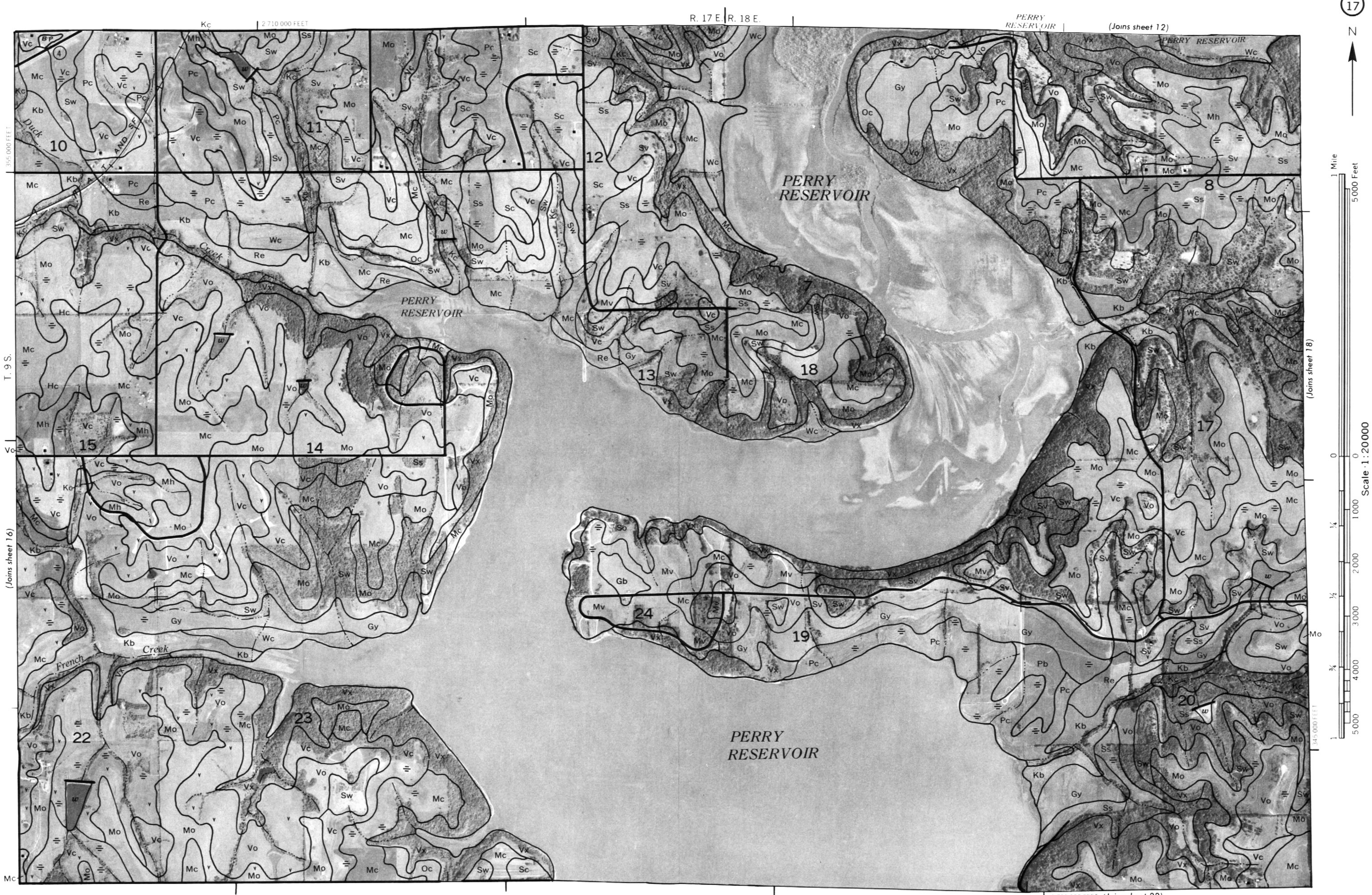
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JEFFERSON COUNTY, KANSAS — SHEET NUMBER 16



This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

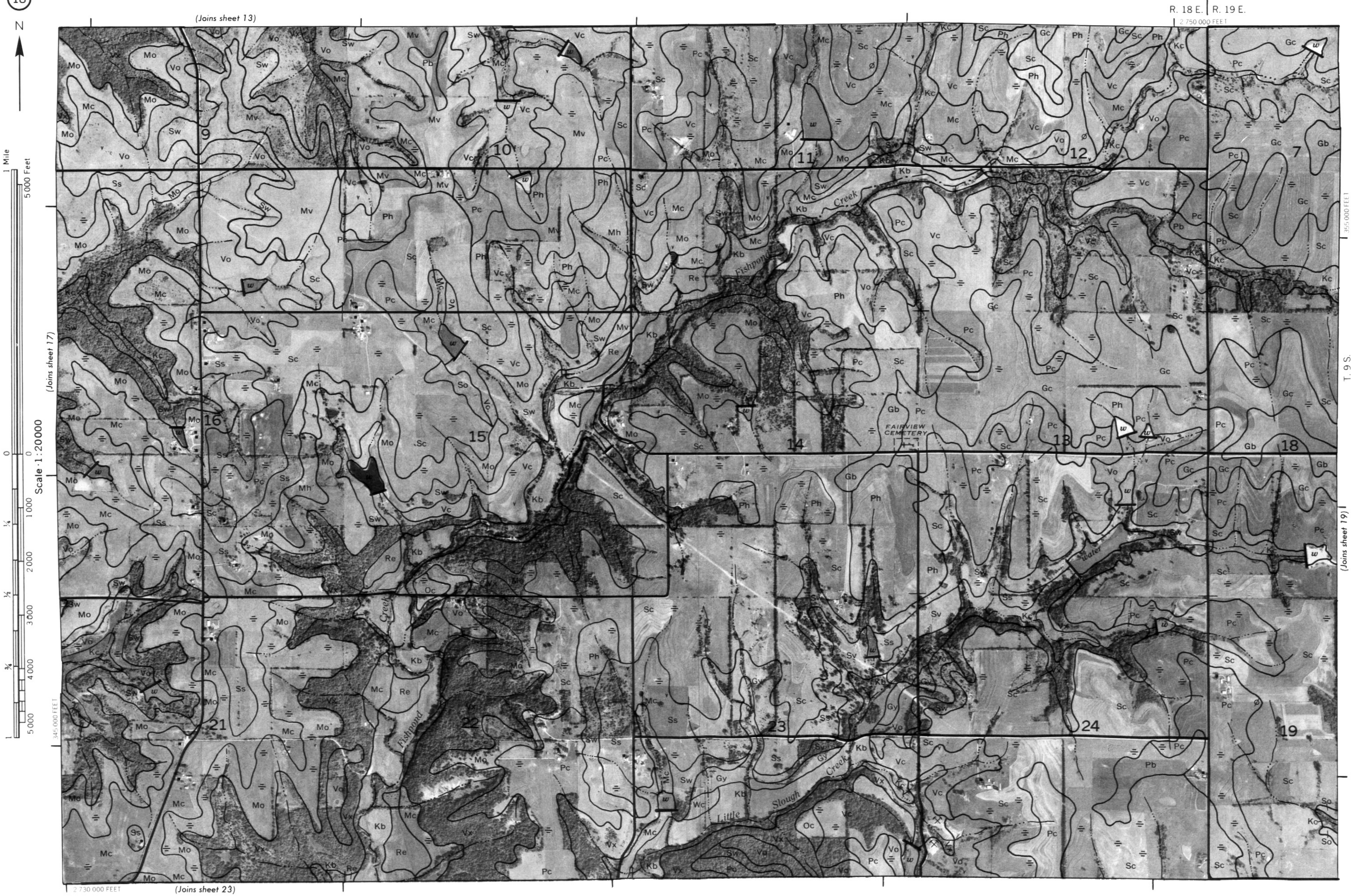
JEFFERSON COUNTY, KANSAS — SHEET NUMBER 17



JEFFERSON COUNTY, KANSAS NO. 17

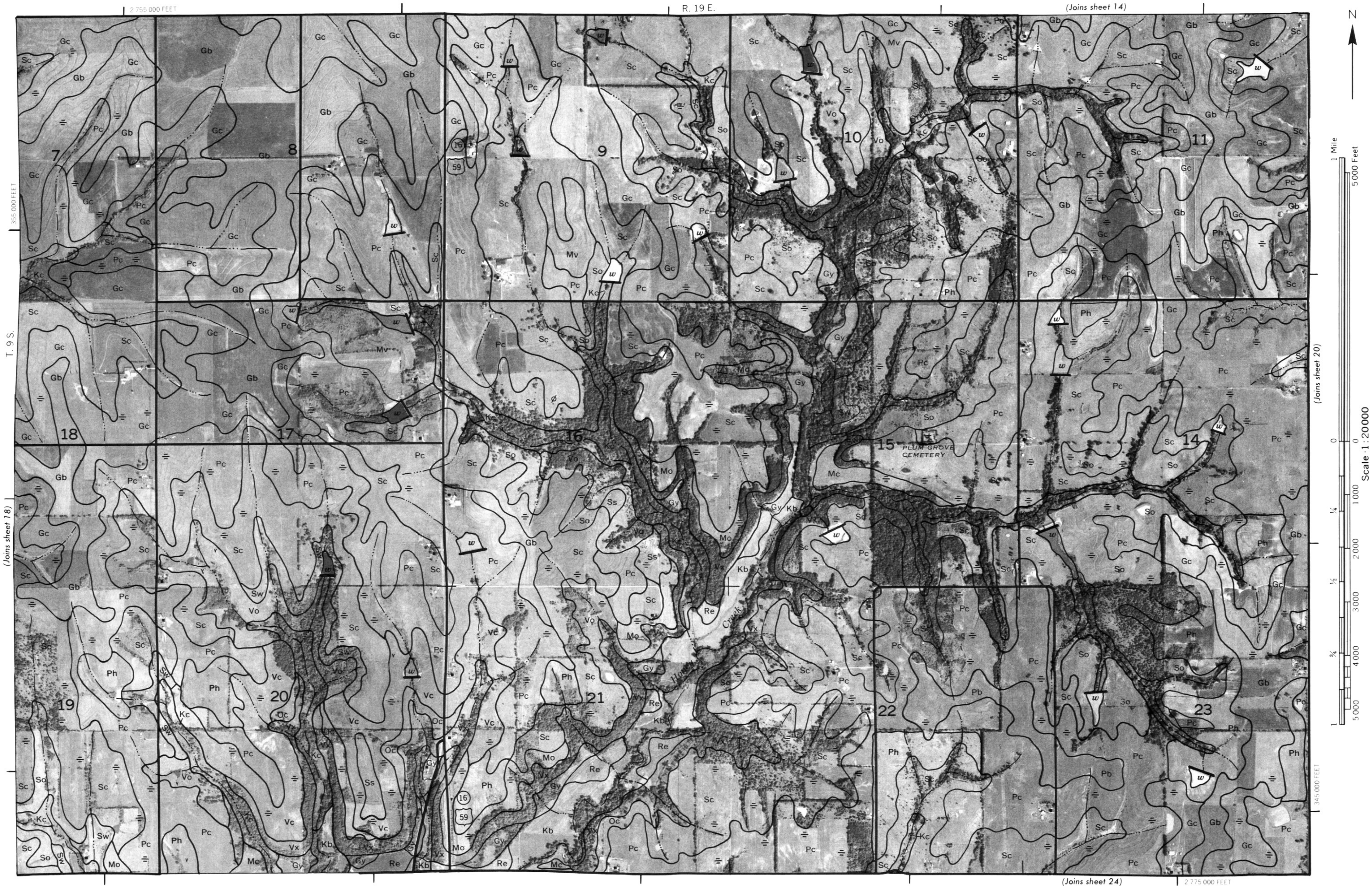
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JEFFERSON COUNTY, KANSAS — SHEET NUMBER 18



This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

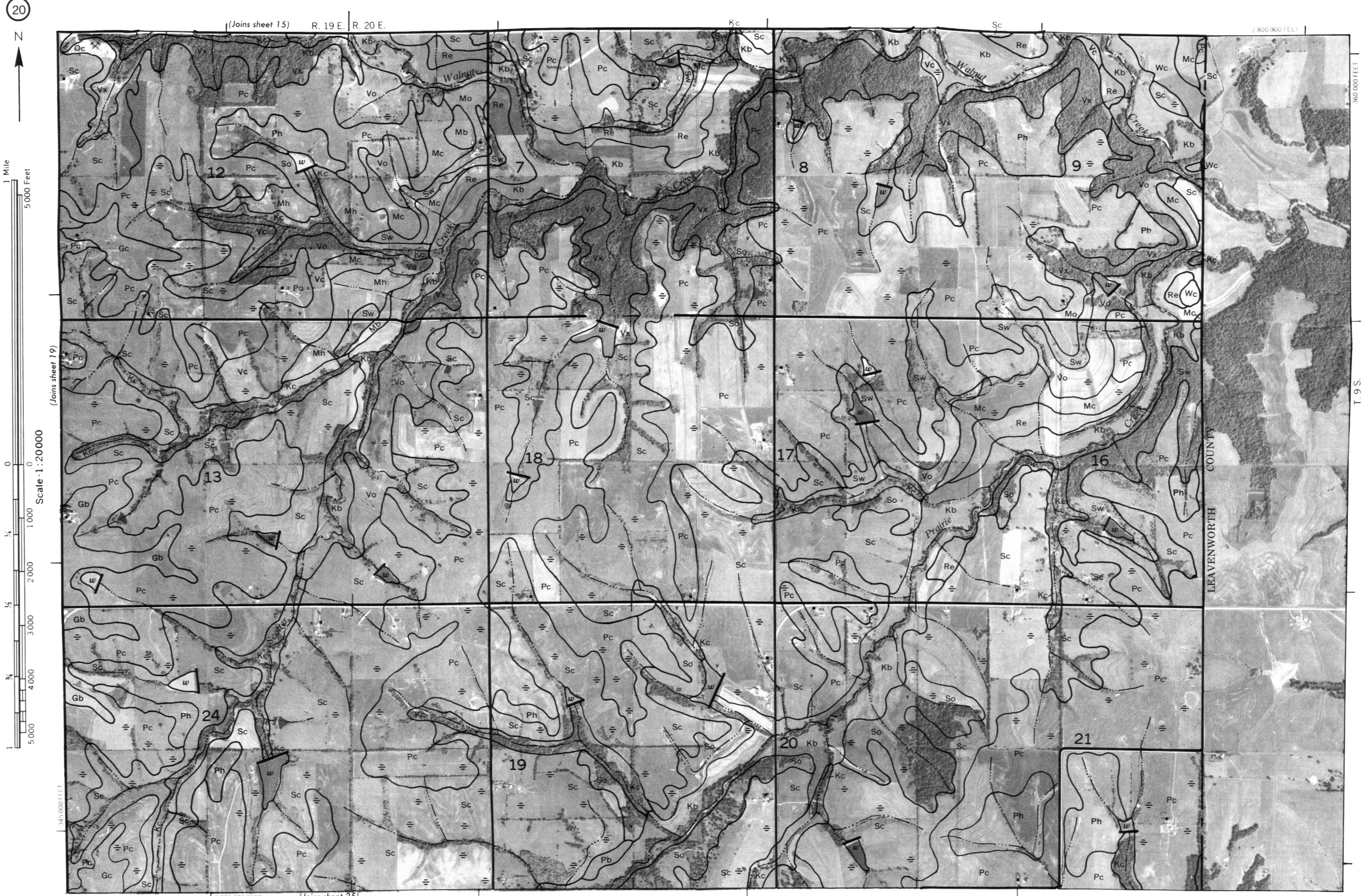
JEFFERSON COUNTY, KANSAS NO. 18



JEFFERSON COUNTY, KANSAS NO. 19

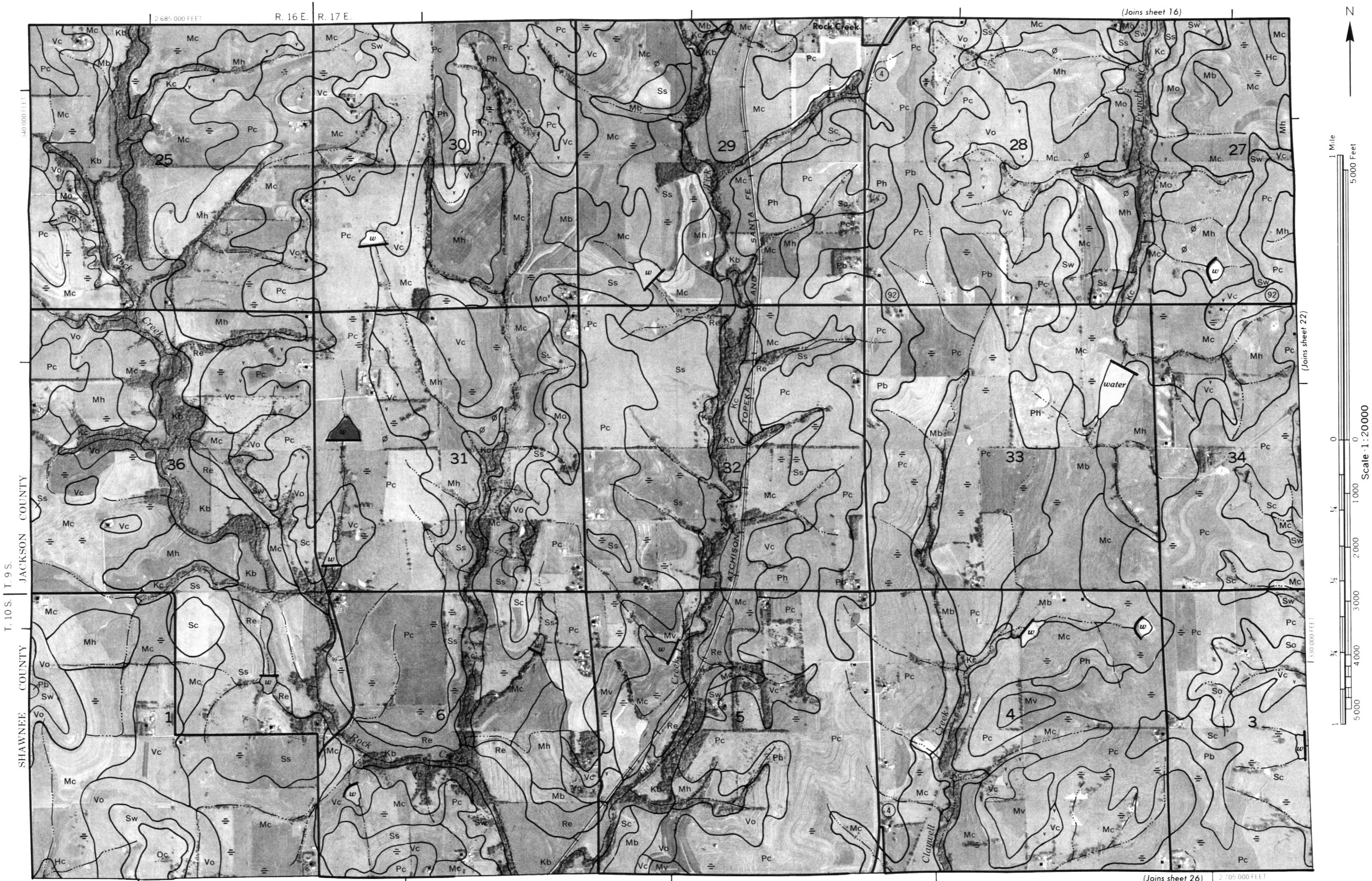
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JEFFERSON COUNTY, KANSAS — SHEET NUMBER 20



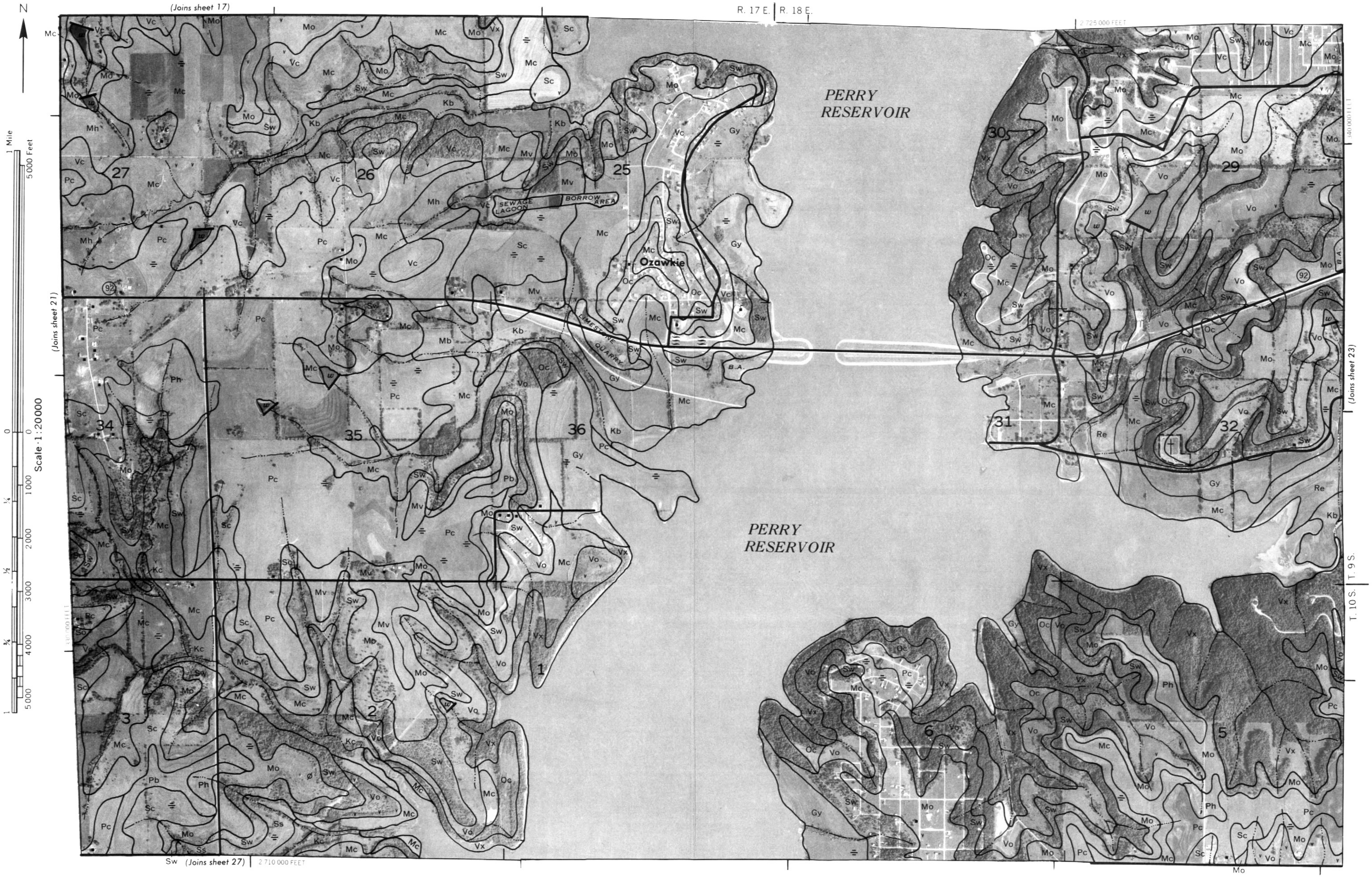
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

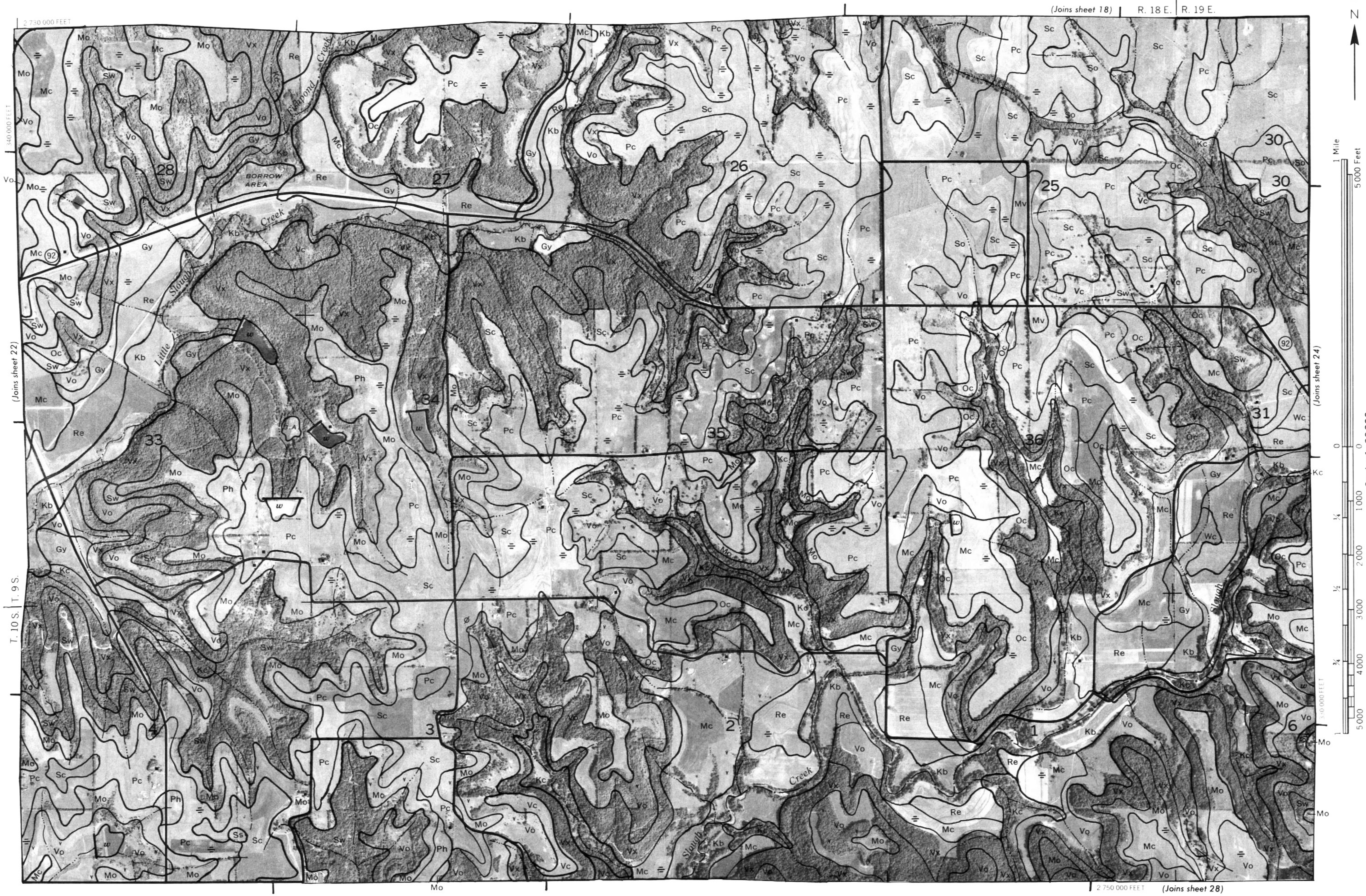
JEFFERSON COUNTY, KANSAS NO. 20



JEFFERSON COUNTY, KANSAS NO. 21

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

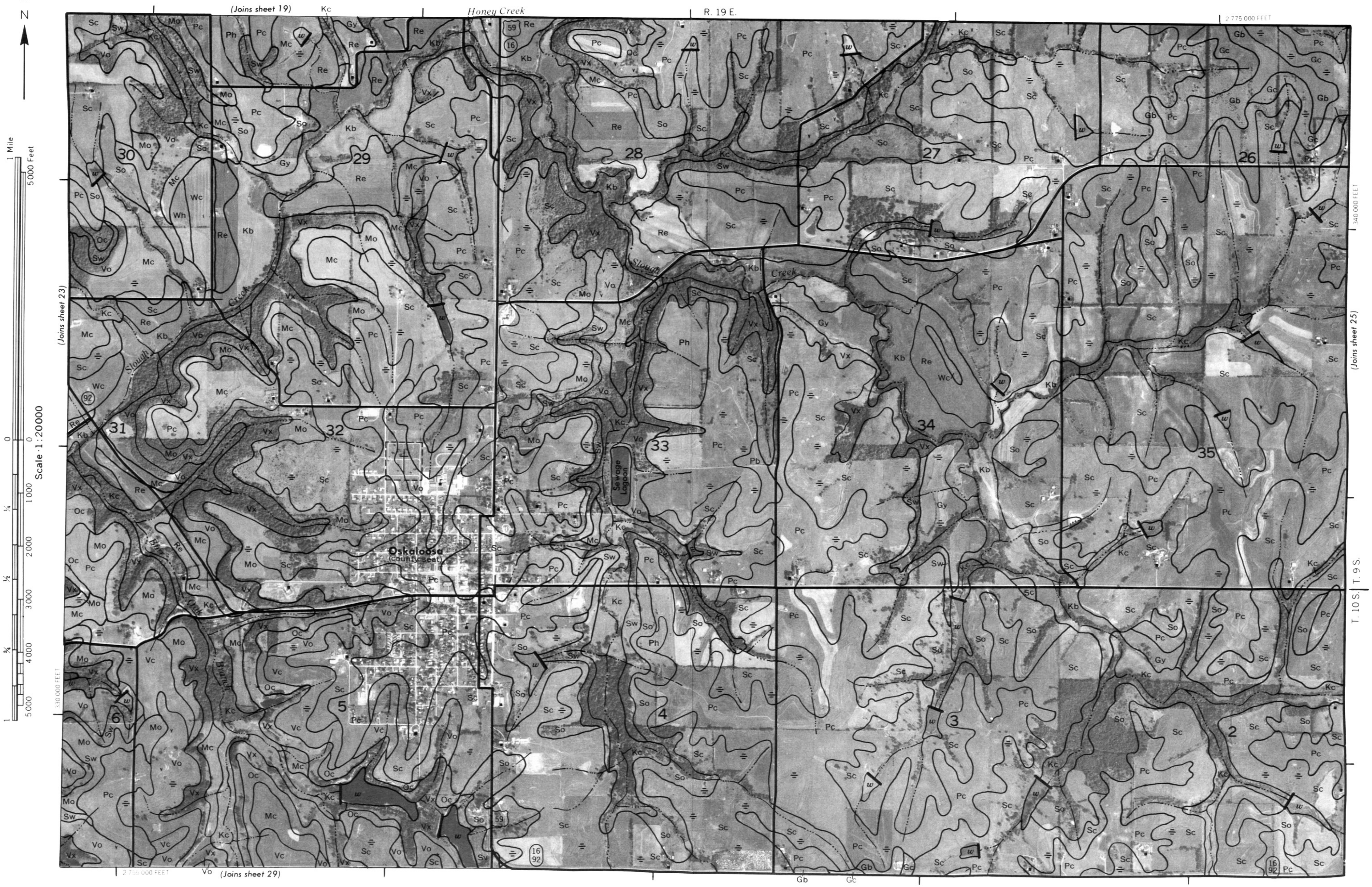

N
(Joins sheet 17)
R. 17 E.
R. 18 E.
2 725 000 FEET
PERRY RESERVOIR
SEWAGE LAGOON
BORROW AREA
Ozawkie
LIMESTONE QUARRY
B.A.
(Joins sheet 21)
(Joins sheet 23)
T. 9 S.
T. 10 S.
PERRY RESERVOIR
(Joins sheet 27)
2 710 000 FEET
27
26
25
30
29
34
35
36
31
32
1
2
3
6
5
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
0
¼
½
¾
1



JEFFERSON COUNTY, KANSAS NO. 23

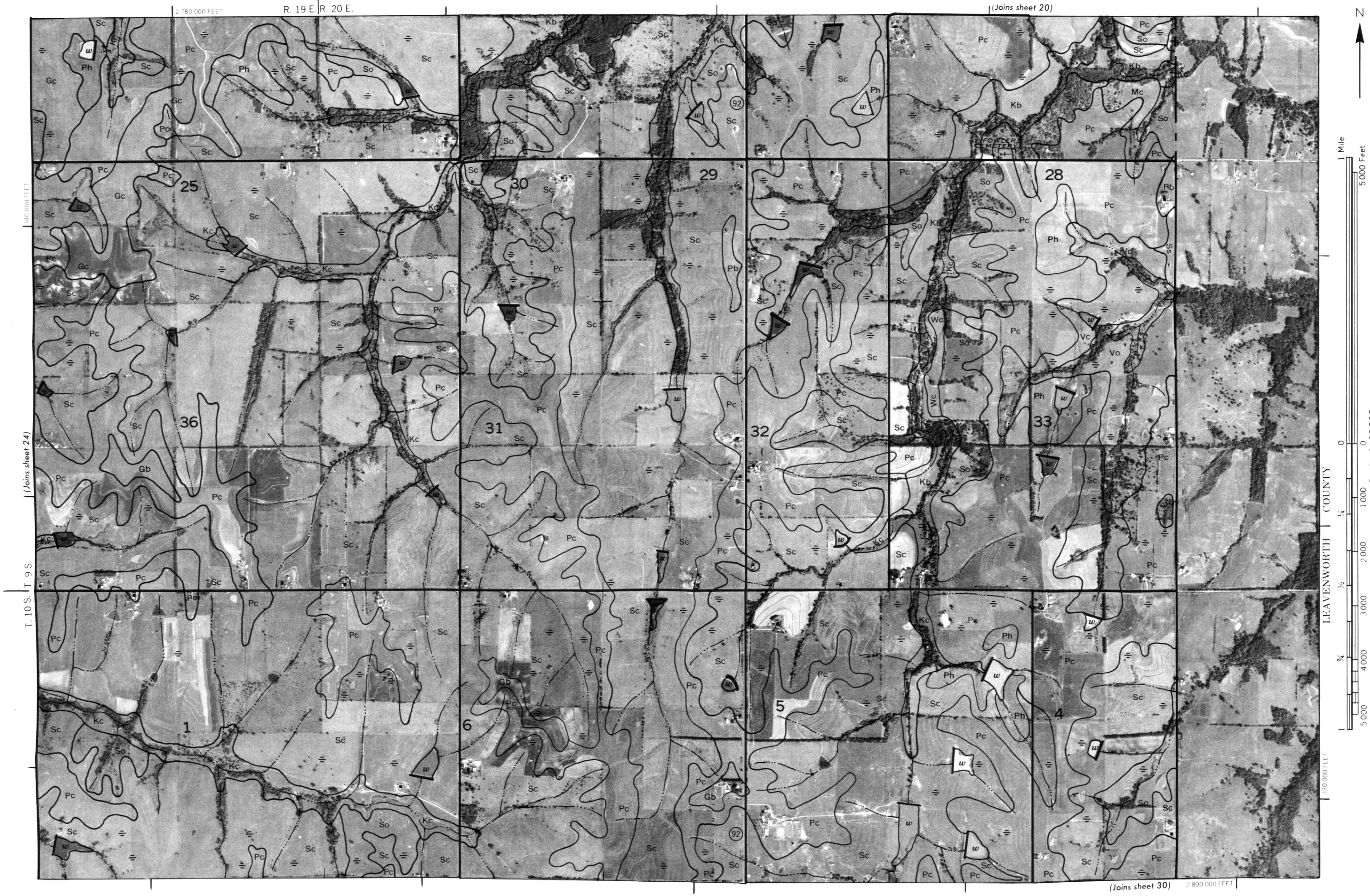
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JEFFERSON COUNTY, KANSAS — SHEET NUMBER 24



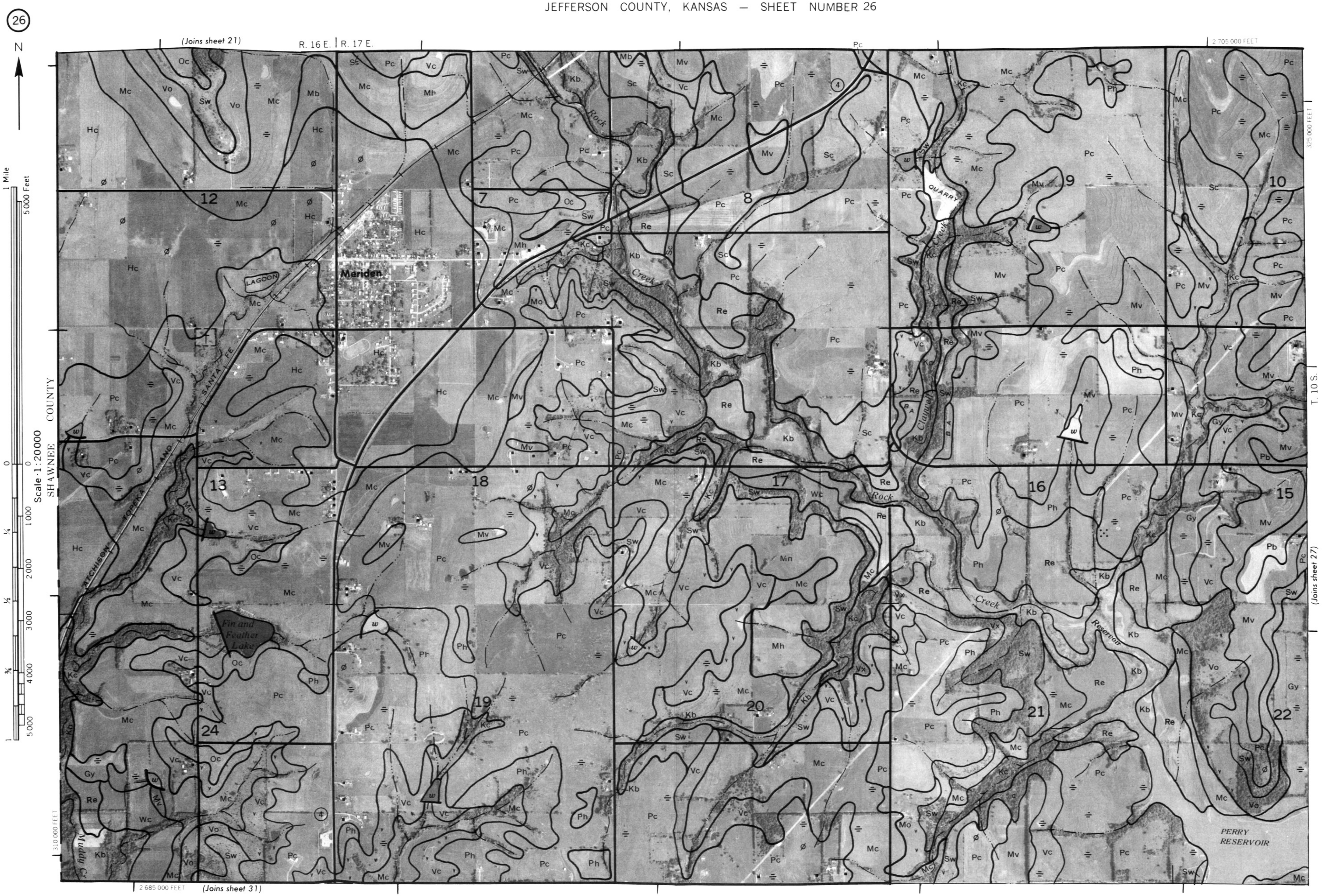
This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JEFFERSON COUNTY, KANSAS NO. 24



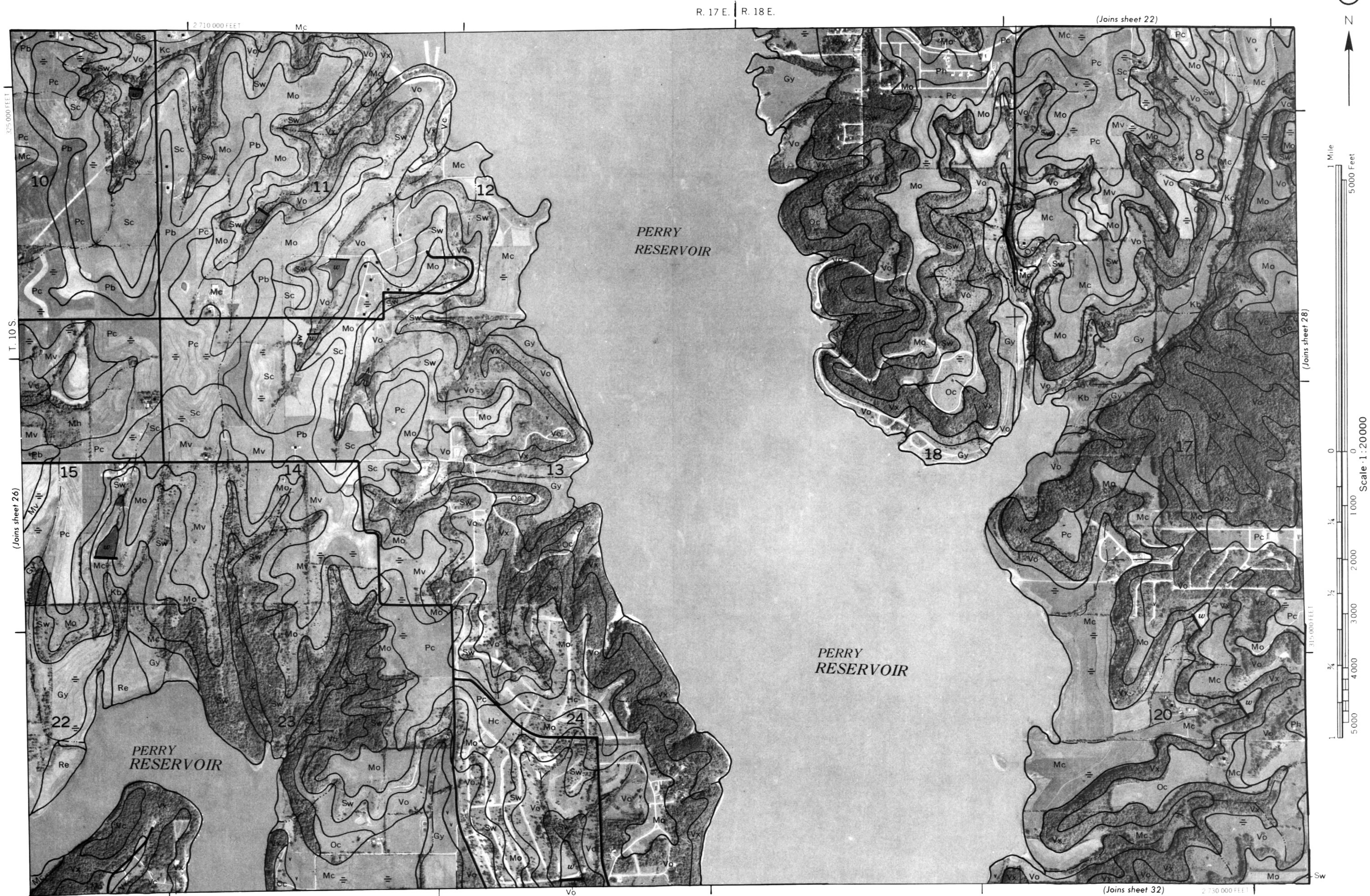
JEFFERSON COUNTY, KANSAS NO. 25

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JEFFERSON COUNTY, KANSAS NO. 26

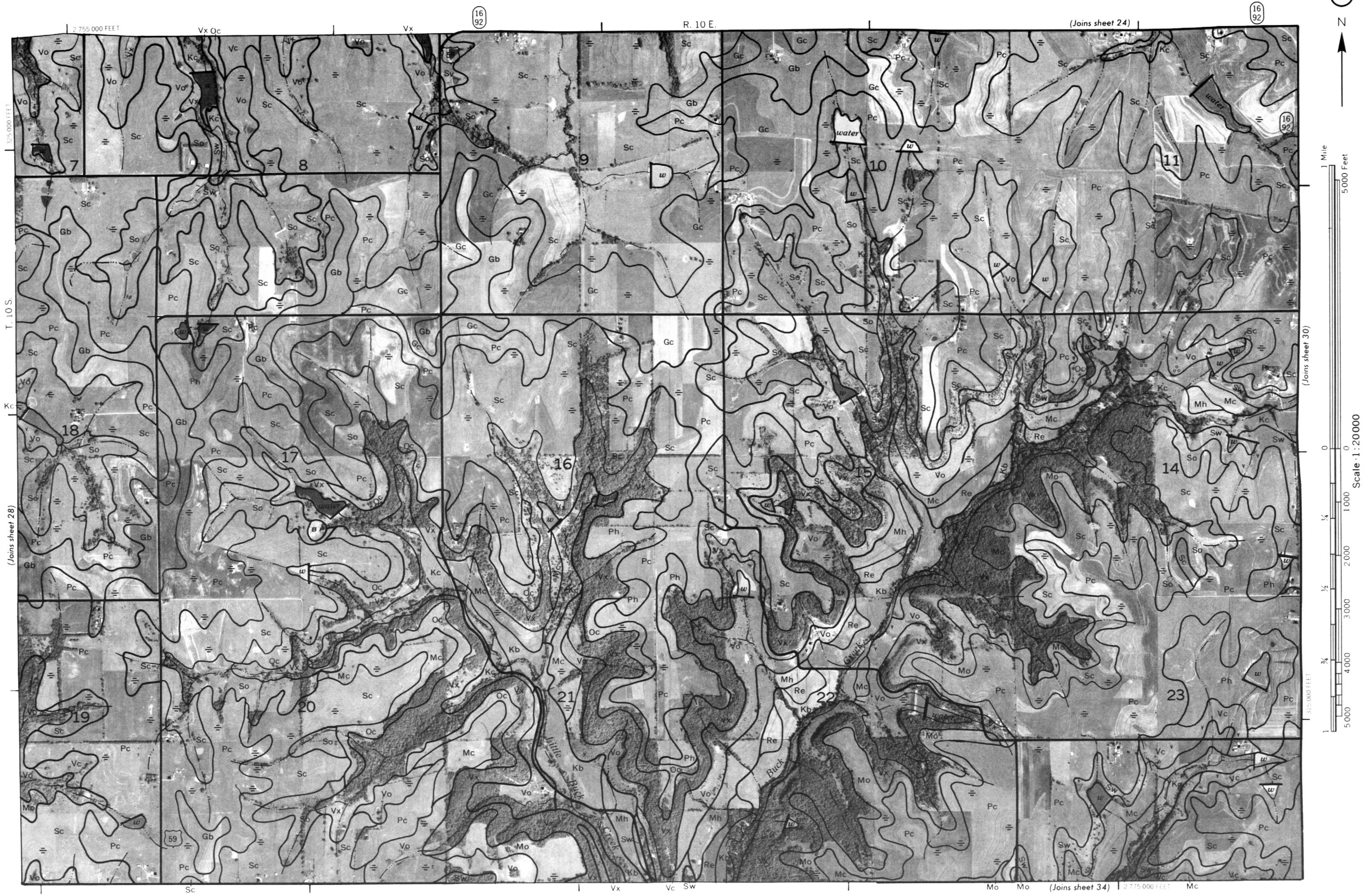


JEFFERSON COUNTY, KANSAS NO. 27

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

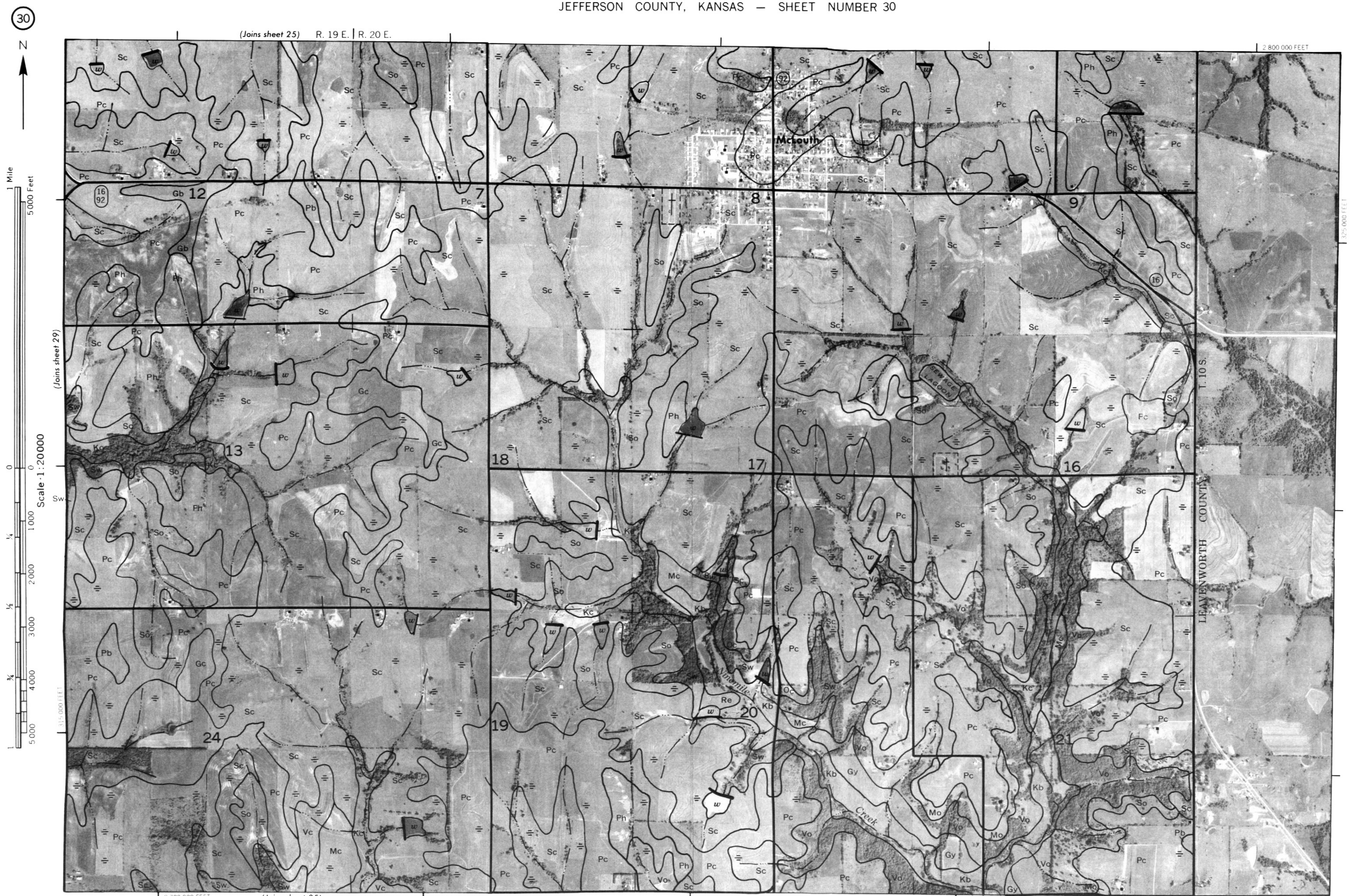
This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JEFFERSON COUNTY, KANSAS NO. 28



JEFFERSON COUNTY, KANSAS NO. 29

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

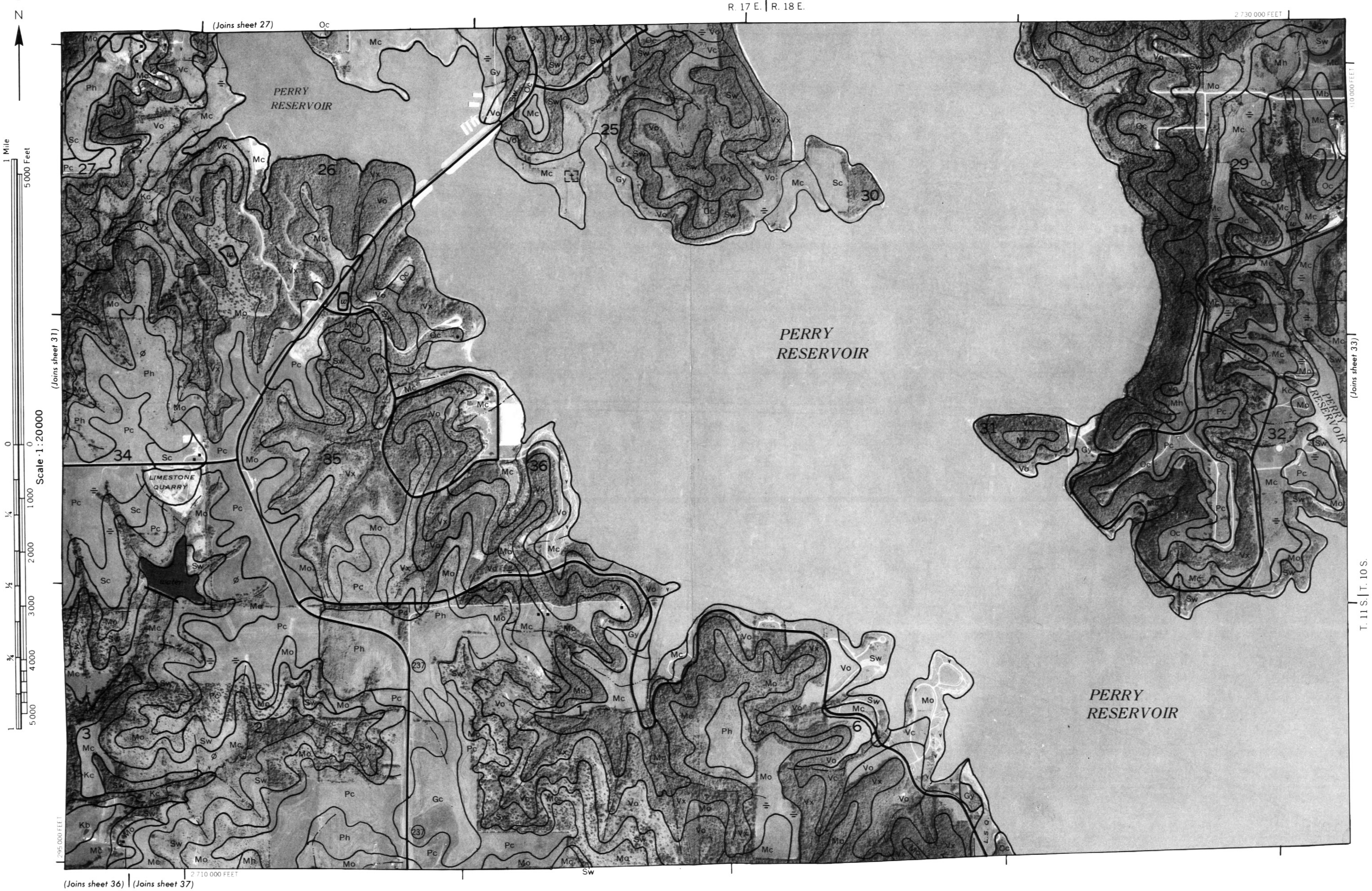
JEFFERSON COUNTY, KANSAS NO. 30

31

JEFFERSON COUNTY, KANSAS NO. 31

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

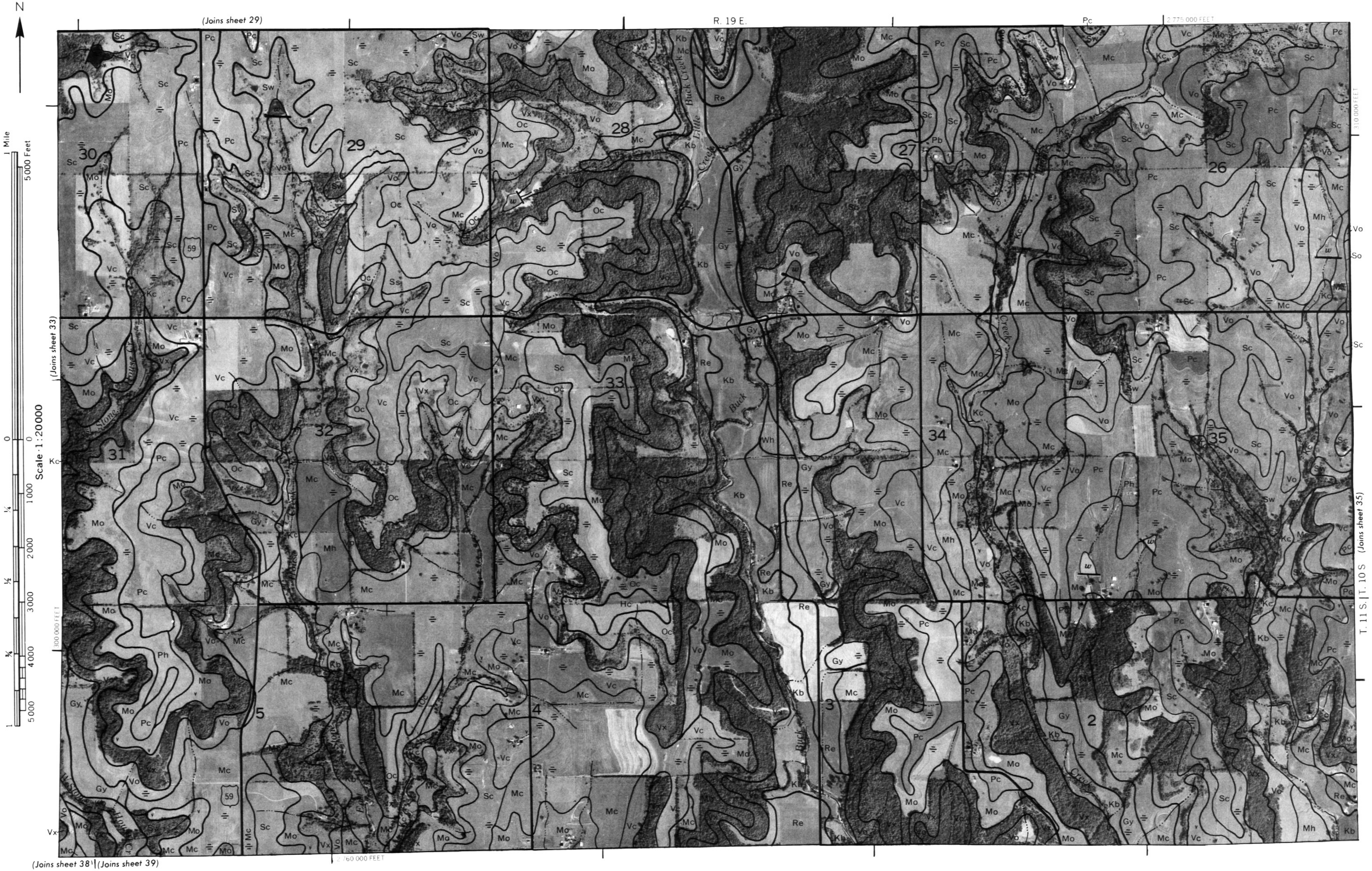
JEFFERSON COUNTY, KANSAS — SHEET NUMBER 32



JEFFERSON COUNTY, KANSAS NO. 32

JEFFERSON COUNTY, KANSAS NO. 33

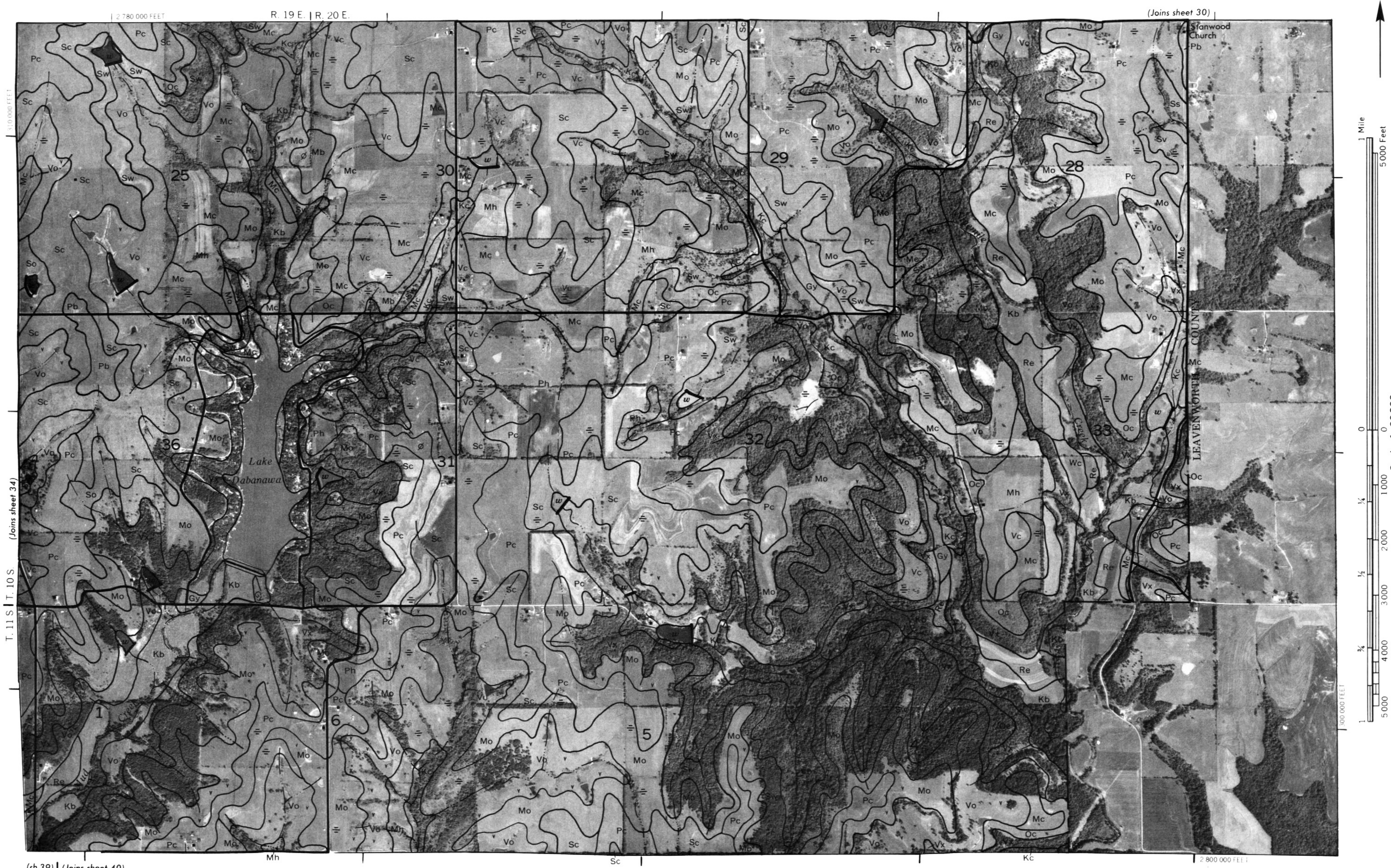
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JEFFERSON COUNTY, KANSAS NO. 34

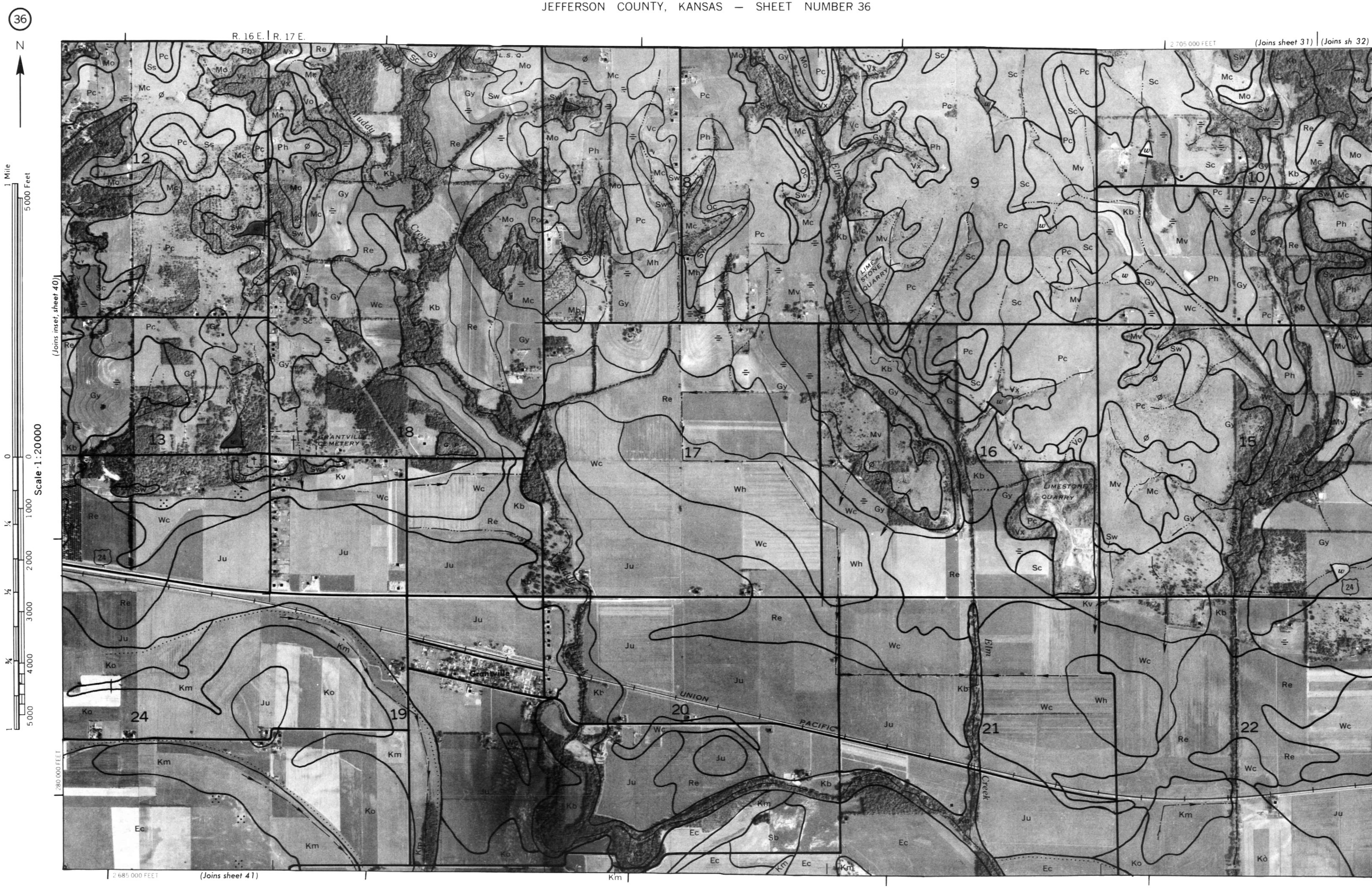
35



JEFFERSON COUNTY, KANSAS NO. 35

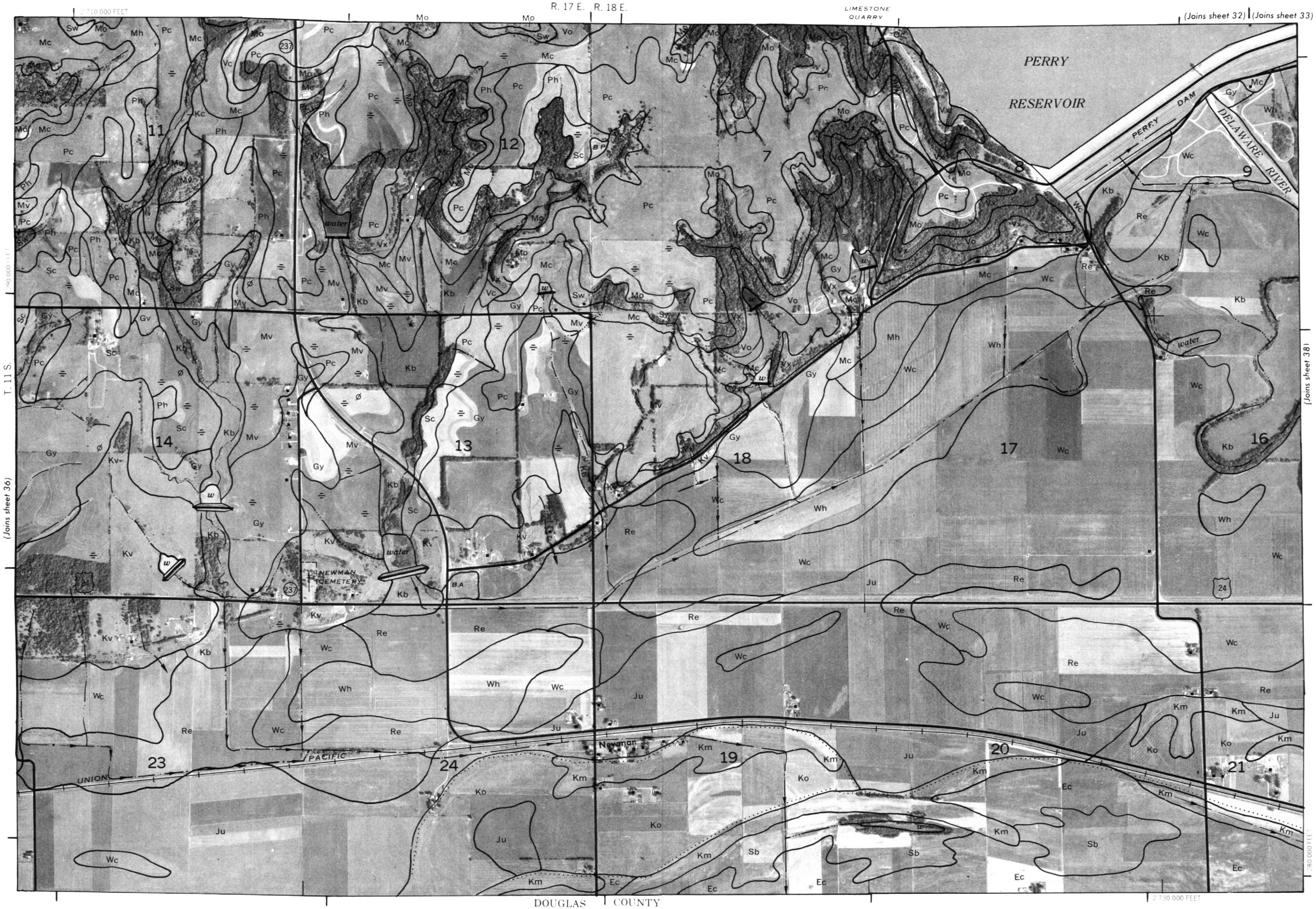
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JEFFERSON COUNTY, KANSAS — SHEET NUMBER 36



This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JEFFERSON COUNTY, KANSAS NO. 36



N

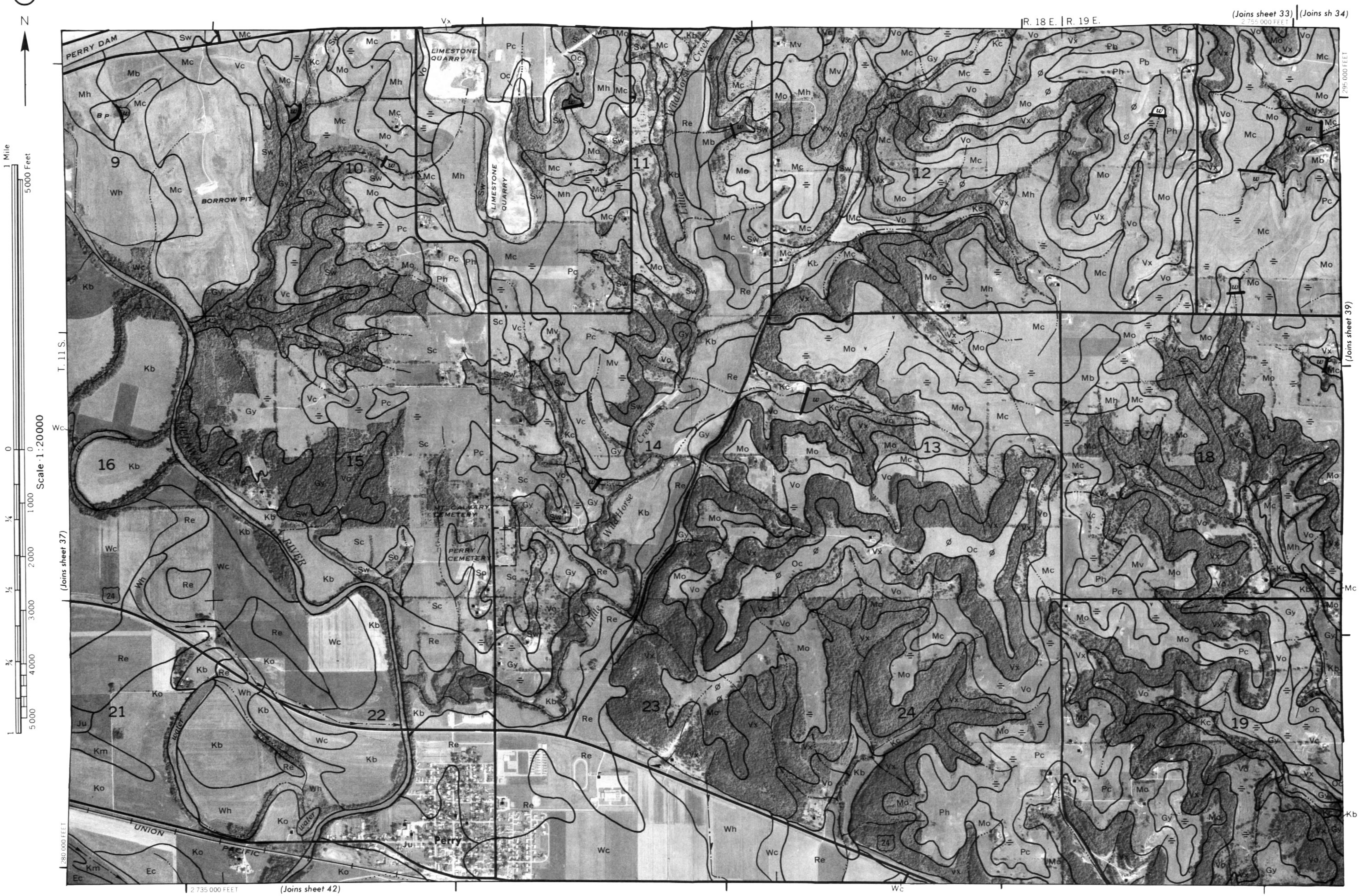
Scale 1:20000

1 Mile

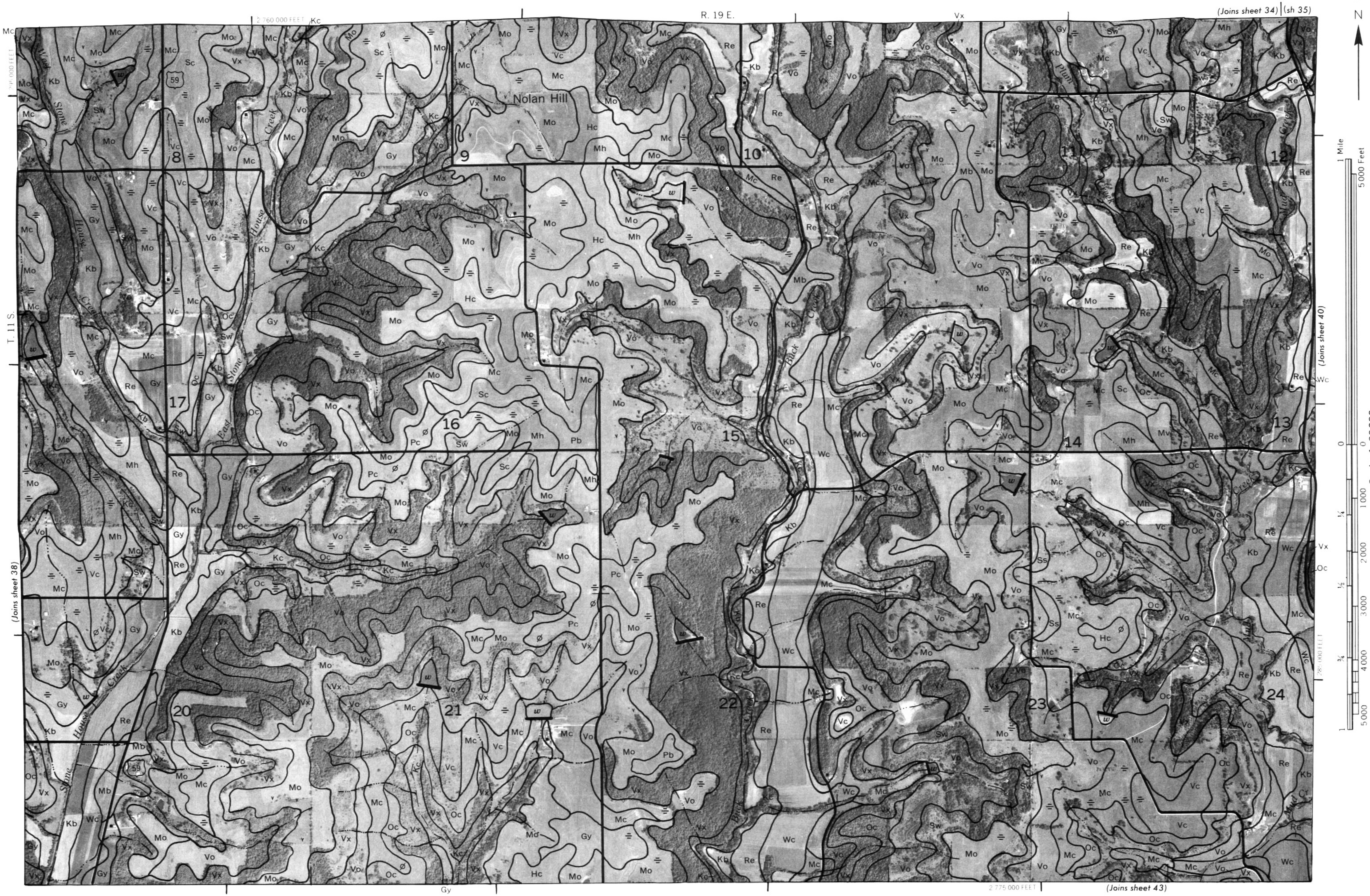
5000 Feet

JEFFERSON COUNTY, KANSAS NO. 37

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

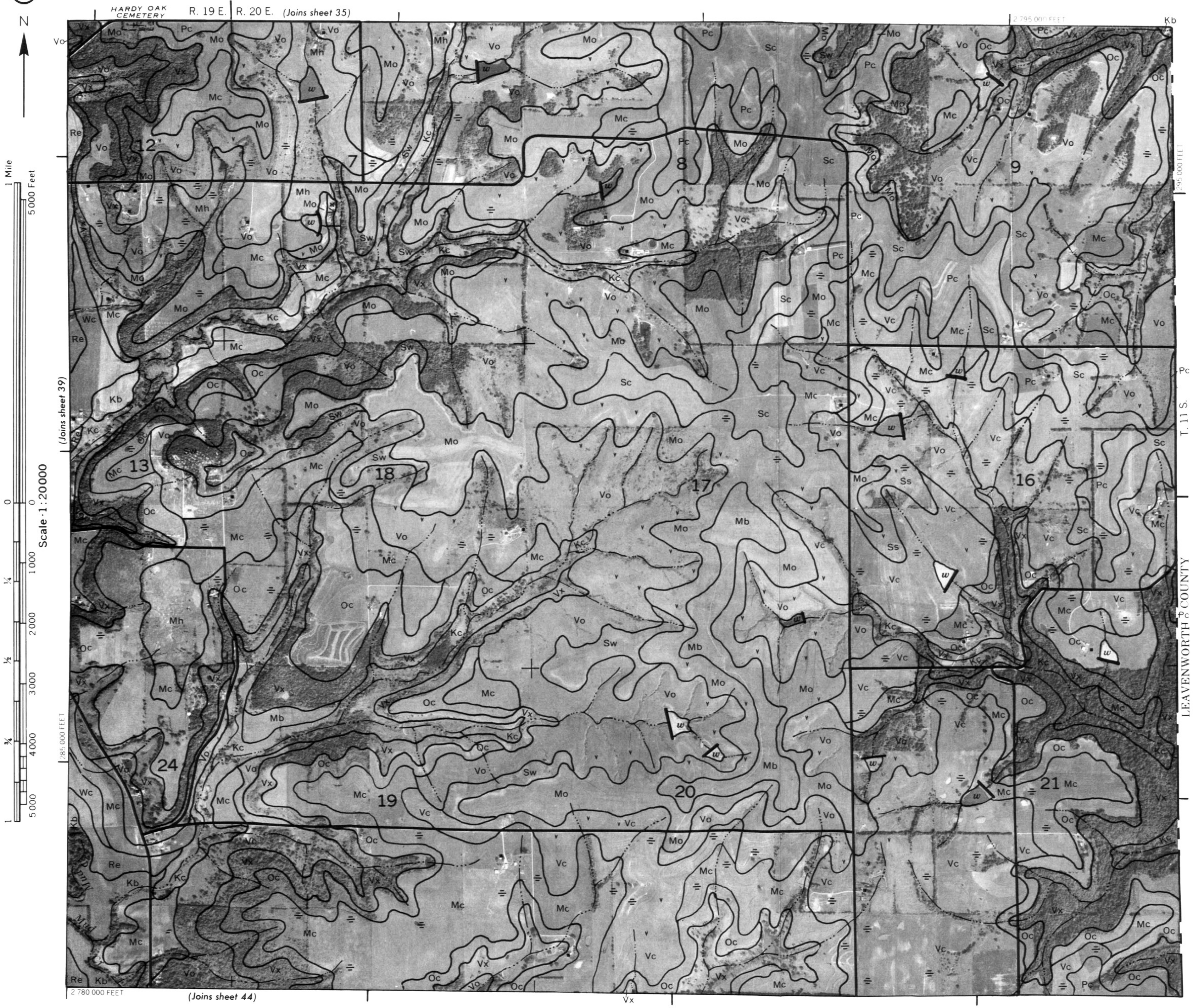


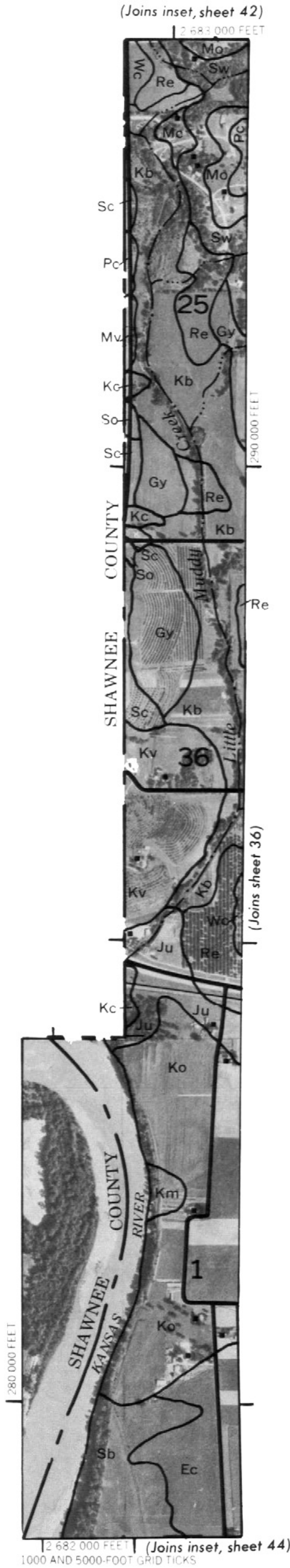
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



JEFFERSON COUNTY, KANSAS NO. 39

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





JEFFERSON COUNTY, KANSAS NO. 40

41

JEFFERSON COUNTY, KANSAS NO. 41

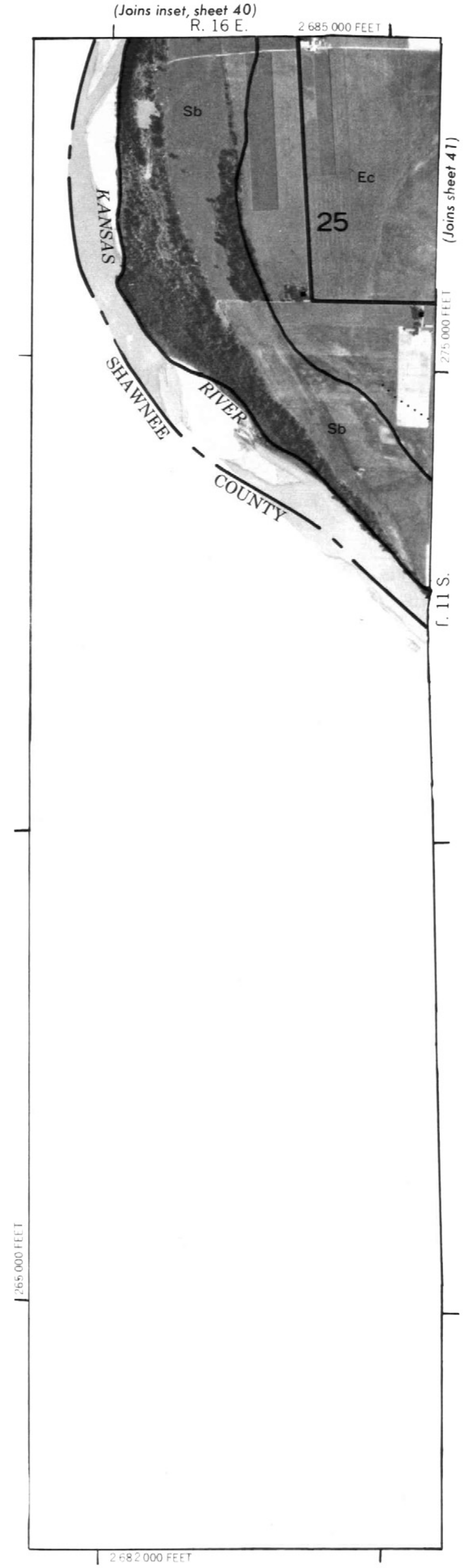
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JEFFERSON COUNTY, KANSAS NO. 42

JEFFERSON COUNTY, KANSAS NO. 43

This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



3000 AND 5000-FOOT GRID TICKS

This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JEFFERSON COUNTY, KANSAS NO. 44